METALLURGIA

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The British Industries Fair

Some Interesting Metallurgical Features.

IT is significant that the British Industries Fair, organised by the Department of Overseas Trade, to be held from February 22 to March 5 inclusive, is of greater magnitude than ever. Although many disturbing factors are interfering with trade recovery, and industry is experiencing a prolonged and serious depression, the remarkable response by manufacturers and producers, in taking space, indicates the high degree of confidence in the possibilities of British industry. This Fair, sections of which will be held at Olympia and White City, London, and at Castle Bromwich, Birmingham, provides an opportunity of seeing by far the greatest display of entirely national manufactures held in any part of the world.

Primarily organised for the purpose of bringing about more effective selling of products, the complete success of which would materially assist in the solution of many disturbing problems, the Exhibition also provides the most comprehensive illustration of improvements and developments that have been effected during recent years. Strenuous efforts have been made to revitalise trade by the development of new industries, the improved quality of materials, by the most modern machinery, and in adopting the latest technique, in order to cheapen production and increase its scope. The result of these efforts will be exhibited at this Exhibition, and the visitor will not fail to wonder at, and appreciate, the enormous potentialities of the British Empire.

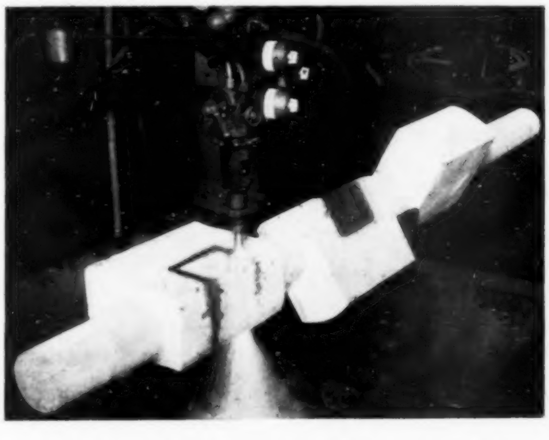


Fig. 1.—Gapping out a crankshaft forging with a 55-in. oxygen cutting machine, by British Oxygen Co., Ltd.

As usual, the lighter products will be exhibited at the London sections, and among the many interesting features of metallurgical interest will be the increasing use of metals and alloys, particularly the corrosive resistant alloys, and the section devoted to scientific and optical instruments. The more interesting of the metal and engineering trades exhibits will be at Castle Bromwich, at which the developments in materials, processes, plant, and equipment have a more definite metallurgical application.

Both in London and Castle Bromwich sections practical demonstrations will not only assist possible buyers in meeting their requirements, but will prove of immense educational value, from which other industries may be developed. It is very important that each firm exhibiting should have a competent staff available to deal with inquiries; this not only facilitates more intimate contact, but is more satisfactory to all concerned.

Laboratory Equipment.

Developments in industry are almost invariably the direct result of intensive research in one or more of its many branches, and appropriate investigations are nowadays recognised as being essential to progress. Many manufacturers appreciate the need for improved or new products, and find it profitable to carry out tests and investigations in their own laboratories. For this purpose it is essential that laboratories should not only be adequately staffed but have installed modern equipment. This is particularly true of metallurgical laboratories in view of the wide range of complex alloys which have become so essential to modern engineering. Special apparatus and equipment for this purpose will be exhibited at Olympia; a section being allocated in which many firms unite in forming a very comprehensive display. Scientific instruments will be on view, which have a definite practical application. An interesting instrument of this type is the Spekker Steeloscope, by Adam Hilger, Ltd. which provides an instantaneous check upon the nature of any steel specimen, without any special preparation or sampling. It not infrequently happens that doubt arises in the course of operations in a steelworks, or the works of a large-scale user of steel, as to the identity of a particular steel, and a more or less urgent need of a rapid means of identification is felt. This instrument has been designed to meet such a need. An electric arc is formed between the specimen under test and a rod of pure iron, and the emitted light is examined by means of this instrument. This specially designed spectroscope, shown in Fig. 2, is very simple to apply.

Actually it resolves the light into its component spectrum lines, groups of which are separately examined at various settings of a sliding eyepiece. Each group contains lines specially characteristic of an element which may be sought in a steel, and whose symbol is indicated by an arrow engraved on the eyepiece. Familiarity with the important lines is rapidly acquired by the aid of the photographic "maps" provided.

With the aid of this spectroscope scrap steel can be readily sorted, and the avoidance of metal containing injurious ingredients is rendered comparatively simple. For use with brasses and bronzes a similar instrument, slightly modified, is made.

Quite a wide range of metallurgical microscopes will be shown in this section, among which will be many by C. Baker, which, although of the highest precision, will be found to be extremely moderate in price. Notable of the exhibits by this manufacturer is a profile projection apparatus which is of great interest. All who have been engaged on the examination of small parts under a

microscope, over a long period will appreciate the eye strain entailed. This projection apparatus overcomes the difficulty, and enables the continuous examination of small parts to be carried on for a long period. A large image is projected on to a board giving all the characters of the object under inspection. The instrument, which is shown in Fig. 3, can be readily adjusted to alter the size of the image.

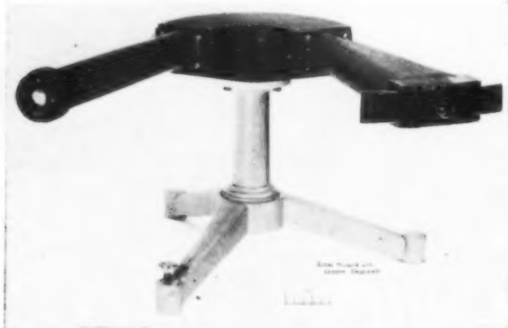


Fig. 2.—The Spekker Steeloscope, by Adam Hilger, Ltd.

Messrs. George Nobbs, Ltd., show some interesting apparatus applicable to metallurgical work. Of these mention may be made of the "Maclaren" electric furnace, designed for subjecting metals to creep test. Fitted with an F.N. pattern thermostat, this furnace enables specimens to be kept at a predetermined temperature for long periods, whilst undergoing conditions of stress. The "Maclaren" thermostat has a straight mechanical make-and-break action, operated by the expansion and contraction of the sleeve immersed in the material to be treated, or within the chamber in which a steady temperature is desired. It is graduated with a range of temperatures up to a maximum of 1,000° C.

It is not possible in a pre-exhibition issue to deal with all the exhibits of metallurgical interest which will be represented at the Castle Bromwich section. On going to press many firms occupying space had not determined the range of products they intended showing; information, however, has been available on many outstanding features that will prove of value to readers and will save them time when visiting the Fair, as well as assist them by preventing important exhibits being overlooked.

The continued development and improvement in technique is improving the standard of manufacture of iron and steel, as well as non-ferrous metals. New applications have widened the field, and new products have necessitated new tools and equipment to meet their special needs, so that production operations can be performed economically. The increasing need for high-grade pig irons is now being met by special refined iron which has been remelted from pig iron to give desired analyses within very narrow limits. Those interested in pig irons should not fail to examine the various grades exhibited by the United Steel Companies; the samples of pig irons by Stewarts and Lloyds; and fractures of numerous grades shown by the Staveley Coal and Iron Co., will indicate that progress is being made towards closer limits of analysis in this essential raw material.

Iron and Steel.

While considerable development has taken place in alloy steels and non-ferrous metals, wrought iron and mild steel, in various forms, will continue to be in constant demand. The advantages of high-grade wrought iron include resistance to atmospheric corrosion, high strength to resist sudden stress and unequal loads, as well as ease in working. These features make it a valuable structural material, and, with mild steel, is finding increasing applications for pressings, tubular sections, as well as a wide variety of semi-finished forms, the utility of which is continually being appreciated.

Fig. 3.
Profile Projection Apparatus, by C. Baker.

Amongst the exhibits demonstrating the wide range of manufactures, the associated companies comprising the United Steel Companies, Ltd., are showing a series of large showcases containing specimens of steel sections and plates, steel rails and sleepers, special steel wires and cold worked steels for the textile industries, drop stampings and small forgings, and of steel billets, bars and strip and articles made from them.

Improvements in tubular processes have been instrumental in developing the use of tubes for a wide range of purposes. Visitors should inspect the exhibits of the Britannia Tube Co., Accles and Pollock, Ltd., the British Tube Mills, Ltd., to obtain some conception of the applications of steel tubing. A comprehensive display of tubes and other wrought-iron and mild-steel components is also shown by Stewarts and Lloyds. Special attention is drawn to the "Dawson" joint this firm is exhibiting, which has been specially designed for the severe strains obtaining in modern installations. This joint is simple and effective, the tube ends being thickened as well as swelled in order to maintain maximum strength.

Among the many exhibits of semi-finished steel products will be the super bright turned bars, bright drawn bars and cold-rolled strip of the British Rolling Mills, Ltd. An interesting feature of this exhibit will be a press in action producing deep pressings from "Brymill X" special deep-stamping steel, which will show the high ductility of this material. Visitors interested in the making of pressings should take the opportunity of making comparisons with their own practice.

Alloy steels are used for such a multitude of finished products that it is difficult to give their range. Perhaps their highest application is to be found in aeroplane engineering, and it is questionable whether the modern machine would have achieved such remarkable speeds had alloy steels not been produced. The term "alloy" is employed to designate steels which owe their properties to the presence of one or more alloying elements other than carbon, and the effect of the introduction of such materials is to give the finished materials special properties.

Stainless steel affords an instance of the value of alloy steels, and there will be many exhibits which will illustrate the progress made with this type of steel. Notable of these will be the display of Thos. Firth and John Brown, Ltd., who will again show the remarkable advances made during the year in the application of Staybrite steel to domestic and engineering fittings. The advances in the technique are, this year, of an even more notable character than those of past years, owing to the progress of scientific research resulting in the inclusion of remarkable new patented steels in the Staybrite family. Chief amongst these is Firth patented F.D.P. steel which has been introduced to meet conditions under which the proper heat-treatment of bulky fabricated and welded plant is impossible owing to lack of facilities in furnace capacity, etc. This steel when fabricated needs no heat-treatment, and completely avoids all complications of disintegration at both heavily manipulated points and welded joints.

On the other hand, manufacturers have been more than usually successful in their application of Staybrite steel to the domestic markets, and apart altogether from the cleverness and utility of most of their products, the market for these modern lines has been found to be increasingly responsive. A very complete exhibit of Staybrite domestic wares created by leading manufacturers, together with a wide range of technical exhibits of interest chiefly to manufacturers, will be of more than ordinary interest.

Several different types of stainless steel, in addition to the ordinary austenitic variety containing approximately 18% chromium and 8% nickel, will be exhibited by Darwins, Ltd. This firm will also be showing a number of heat-resisting alloys in the the form of casehardening boxes, burner parts, electric furnace parts, pyrometer tubes, valve seats, pettels, etc. A new exhibit by Darwins, Ltd., comprises two high-chromium alloys which are remarkably resistant to sulphur-dioxide and sulphuretted-hydrogen at high temperatures; these are known as Pireks C.C. and Pireks R.C.C. Both have been developed after considerable research; the former being intended only for use in the form of castings, has a high-carbon content; whereas Pireks R.C.C. has a low carbon content, and is remarkably ductile and malleable at all temperatures. Its acid-resisting properties are claimed to be superior to those of an austenitic nickel-chromium alloy, and it does not work-harden appreciably, which enables it to be readily rolled to thinnest gauges.

The application of high-frequency induction furnaces has made possible the production of a number of alloy steels on a commercial scale, particularly some of those in which cobalt is one of the important alloying elements. A special cobalt-iron alloy of high magnetic permeability, which has a saturation value from 10 to 15% higher than pure iron, is one of the products of this type of furnace, and samples will be exhibited by Darwins, Ltd. The magnetic properties of this metal render it of great value in parts of electro-magnetic apparatus, when extreme magnetic densities are required.

Malleable Iron Castings.

The use of malleable iron castings is increasing as new applications are being discovered, and many exhibits will show the wide range now embraced by this type of product. Amongst the exhibitors mention may be made of Thomas L. Hale (Tipton), Ltd., who claim that their castings can be machined at speeds as high as are adopted in the United States. Fig. 4 illustrates a consignment of castings ready for despatch which this firm secured in the face of American and Continental competition.

An extensive exhibit of malleable castings will also be shown by Coventry Malleable and Aluminium, Ltd., and Leys Malleable Castings Co., Ltd.

Of outstanding interest among ferrous castings will be the lengths of Stanton-DeLavaud spun-iron pipe, which will be exhibited by the Stanton Ironworks Co., Ltd. Soon after the War this Company laid down a plant for the mass production of iron pipe for the conveyance of gas, water, and sewage. This plant has been twice extended, and the introduction of the DeLavaud process has enabled them to supply pipes which are considerably stronger and cheaper than those made in the past. The latest development is the Stanton-DeLavaud spun-iron pipe made in 6-yd. lengths, which is a remarkable achievement. Visitors should inspect the Stanton stand, as it is paved with cast-iron, section which are being used to form permanent non-skid roadways.

A wide variety of sizes in sand-spun and cast-iron spigot and socket pipes are exhibited by the Staveley Coal and Iron Co., Ltd. Included are specimens of flanged pipes and cast-iron pipes lined with concrete.

Non-ferrous Metals.

The applications of the wide range of non-ferrous metals not only industrial but for domestic purposes also are demonstrated in many ways. The I.C.I. Metals, Ltd., for instance, has an office building set centrally on the stand. The whole building, which is roofed in copper in the form of a house or bungalow, and the fittings are intended to demonstrate the uses to which non-ferrous metals are, and can be, applied in building and architecture.

The metal exhibits themselves are divided roughly into six groups, strip and sheet; plates; rods; wire; tubes; and sundries, and are intended to indicate the scope of the Company's activities in non-ferrous metal manufacture. In the plate section there is a complete locomotive firebox in copper, as well as loose firebox plates; while another impressive exhibit is that of large condenser plates, attention being directed to their perfect surface.

Wire in copper, brass, and the usual alloys and gauges is shown in coil from the very thinnest up to the heavy section material, such as is used for trolly buses and electric trams, while a pseudo telegraph standard with insulators illustrates the use of copper and copper cadmium wires for telegraph and telephone purposes.

Much of interest will be shown by the Delta Metal Co., Ltd., A great variety of samples show the wide application of extruded rods. One of the features of this exhibit is the Delta pavilion, made entirely of "Delta" bronzes of various compositions, with glass panels, which shows the artistic value of these bronzes. A selection of "Dixtampo" stamping metals and articles made therefrom illustrate another branch of the Company's products: while the showcases and other exhibits give ample proof of the great variety and high quality of the products marketed by this Company.

J. F. Ratcliff (Metals), Ltd., are displaying rolled brass, rolled copper, "Luster," giving metal, phosphor bronze, etc., which emphasise the high finish for which this firm is noted. These smooth, bright surfaces effect a great saving in polishing costs and facilitate production. This firm aptly use the trade mark for their metal products. Produced in a most up-to-date mill, these materials fulfil the most exacting requirements. Standardising of tempers was first introduced by this firm, and customers making a judicious use of their eight different tempers are agreeably surprised by the speed with which the work passes through their shops, the freedom from waste, and the superiority of their products. It is of interest to note that this firm is showing an interesting cinematograph film, showing the manufacture of rolled metals from the casting of the ingot until the despatch of the finished product.

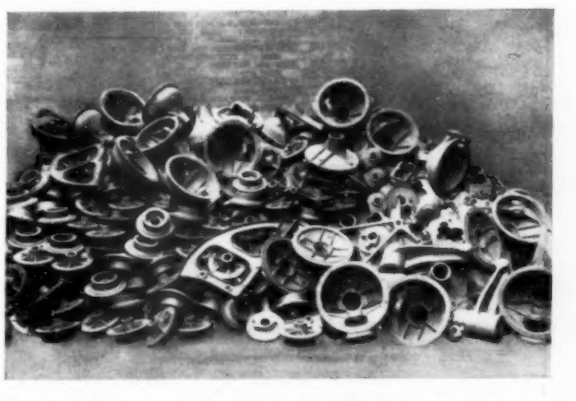


Fig. 4.—Group of malleable-iron castings, by Thos. L. Hale (Tipton), Ltd.

Among many other exhibitors of semi-finished non-ferrous metals the display of Earle, Bourne and Co., Ltd., should not be overlooked. A very comprehensive range of manufactures are shown which include cold-rolled brass of various compositions, copper, aluminium, and aluminium alloy and many other products.

The Telegraph Construction and Maintenance Co., Ltd.,

are exhibiting their high-permeability alloys, Radiometal and Mumetal, and examples are shown of the different forms of strip, sheet wire and rod in which they may be obtained, together with made-up cores for transformers.

The former metal is characterised by its high-incremental permeability. It is intended for use in the cores of audio-frequency transformers, and enables designers to produce

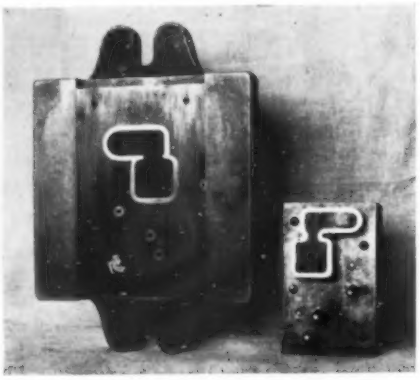


Fig. 5. Stelliting press tools.

instruments which will give a uniform amplification over the whole musical scale.

Mumetal is an alloy having remarkable magnetic properties; for instance, it has an initial permeability of the order of 7,000 to 10,000 with very low hysteresis losses—about one-tenth that of the best Swedish charcoal iron,—and, in addition, it has very high electrical resistance. These unique properties have been utilised in the manufacture of continuously loaded high-speed submarine telegraph cables. The outstanding properties of this alloy will be demonstrated at the Exhibition as follows:—

1. The diminution in the field strength around a coil by the interposing of a Mumetal shield. This is shown by placing a Mumetal screen between a search coil and the source of interference, thereby reducing the hum in a loud-speaker associated with the search coil and an amplifier.

2. Comparison between the reluctance of Mumetal and soft iron. The samples carrying identical windings are rotated in a magnetic field, the current generated in the two cases being compared by deflection of a galvonometer.

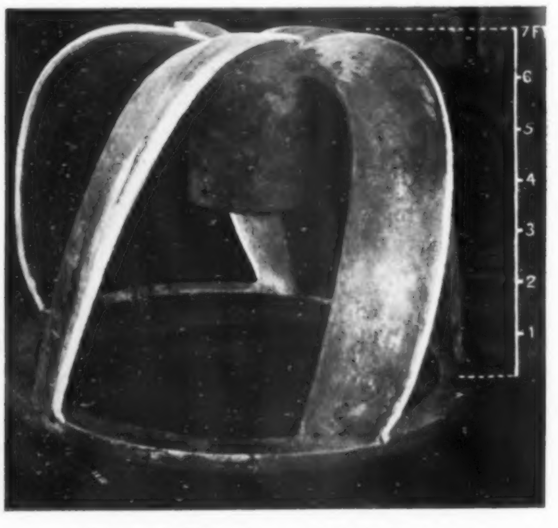


Fig. 6.—Stelliting the cutter blades of a dredge.

3. A demonstration of the comparative permeability of transformer iron and Mumetal. The Mumetal and iron samples are subjected to the same magnetising force, and the induction in the two cases is shown by a deflection of a galvanometer.

4. The low hysteresis of Mumetal is demonstrated by observing the angular deflection of a disc suspended in a rotating magnetic field. The comparison of the deflections give the relative values of hysteresis for the two samples.

Cutting Materials.

In view of the increasing stress of competition too much emphasis can hardly be placed on the necessity for superseding old machinery and old methods by the best and most modern that are available. This is particularly true of machine tools, on which the success of modern developments in cutting materials is dependent. While it is essential that machines should have the maximum rigidity in use with modern cutting tools, full use should be made of these machines by providing the most suitable tools. In high-speed tool steels the matrix in the heat-treated material is a martensite-troostite mixture, which contains considerable tungsten in solution with the iron. The hard particles usually consist of double carbide of iron and tungsten. The fact that this red, hard-cutting material is both forgeable and machinable makes it a universal tool metal. Of the exhibits of tool steels attention should be given to those produced by Darwins, Ltd., and Thos. Firth and John Brown, Ltd. The latter firm are showing a working example of "Insto" inserted tooth saw, which is now fitted as standard to the more powerful makes of sawing machines.

A number of cast alloys covering a range of composition in which cobalt, tungsten, chromium, and carbon are the essential constituents, are manufactured by Deloro Smelting and Refining Co., Ltd. (of Canada), which are given the now familiar name of "Stellite." Long experimental research in alloying and casting this alloy has resulted in the development of a remarkably fine-grained material possessing marked superiority in cutting certain kinds of materials. Containing the most effective element for high-temperature hardness, Stellite provides material for very valuable cutting tools, a fact which is now universally recognised. One important faeture, however, possessed by this alloy is that it can be welded, and this has opened out an immense field of application for which other high-duty cutting materials are unsuited. For this purpose the alloy is cast in rod form, and may be deposited either with the oxy-acetylene torch or by the electric-arc process. The process is known as Stelliting, and consists in welding the alloy to softer materials at places where its great powers of resistance to corrosion and abrasion are desirable in the interest of efficiency and extended life.

The applications of the Stelliting process are now many. It has been particularly appreciated in the mining, smelting, dredging, excavating, pulping, brick, cement, and allied industries, while in several instances it has proved most valuable in the machine shop. The main advantage of Stelliting surfaces is the increased service against wear obtained from the part treated, which varies from three to seven times that of steel. This process presents immense possibilities, two applications of which are illustrated in Figs. 5 and 6. For increasing the life of press tools, or reclaiming them after a period of service, is one of the applications, shown in Fig. 5: while its application to the cutter blades of a dredge, shown in Fig. 6, is an outstanding example of the possibilities of the process.

Developments are now in progress in the application of the process to valve seats of heavy-duty petrol engines, and many of the leading manufacturers of heavy vehicles are investigating its possibilities in this direction. Some of the valve seats which have been treated will be exhibited, in addition to other applications covering a wide range.

Another cutting material which will be exhibited is tungsten carbide, in the form of "Widia." This is a sintered material possessing remarkable power to resist abrasion, and will retain a cutting edge at very high cutting speeds for prolonged periods. This material is having a considerable effect on machine-tool design

because of the higher cutting speeds it makes possible. Widia may be regarded as a cutting medium consisting of tungsten carbide thoroughly interspersed through a matrix of cobalt. It is used for tipping tools, and both tips and tools will be exhibited by A. C. Wickman, Ltd., which will create much interest.

Industrial Heating and Melting.

The choosing of a suitable fuel or electricity for various metallurgical operations is very difficult. So many factors are involved in arriving at a solution to this problem that any one of them may influence the selection under certain conditions. In any consideration of this problem the primary object is to use that form of heating agent, and that type of equipment, which gives efficient and useful service, and it is necessary to keep in mind the whole series of operations involved in production under manufacturing conditions, rather than to single out any one operation in the manufacturing process, because the most economical heating medium is that which gives the highest quality product at the lowest overall cost. Solid, pulverised, gas or oil fuels may be selected, or electricity may more adequately fulfil the conditions. But each fuel has its special field of usefulness, as well as its limitations. The type of furnace or appliance to be used, manufacturing conditions, as well as many other factors, influence the choice. When the subject is carefully considered it will be appreciated that the design of the furnace or appliance has a distinct bearing upon the economic relations between various forms of heating mediums and continued development in plant and appliances modifies these relations.

The Application of Fuel Oil.

Rapid developments have been made during recent years in the application of oil fuel to industry, and a unique opportunity of observing these developments is afforded engineers and metallurgists visiting the Birmingham section of the Fair. One of the largest single exhibits is devoted entirely to the uses of oil fuel for industrial processes. Prepared by Messrs. Shell-Mex and B.P., Ltd., in collaboration with fifteen manufacturers of oil-burning equipment, it will exhibit a variety of oil-fired furnaces under working conditions. Some conception of the extent of this stand is obtained on reference to Fig. 7, which shows a front elevation of half the stand. It embraces a comprehensive display, and should prove both interesting and informative, particularly as experts in the various applications of oil fuel will be available to give visitors the benefit of their experience.

Among the exhibits on this stand is an oil-fired tool-hardening furnace fitted with a new burner recently developed by Alldays and Onions, Ltd. The essential feature of this burner is that the flame burns right back to the burner nose, in addition to which complete control over the length and type of flame is obtainable. The burner (Fig. 8) is arranged for working in conjunction with air at fan-blast pressure of approximately 16 in. w.g., and exhaustive tests show that the results obtained with this burner are greatly superior to those obtained with the old range of burners used by this company.

Messrs. Burdons, Ltd., are exhibiting two furnaces which are of considerable interest. One is a small direct-fired rivet-heating furnace, 24 in. × 14 in., which is fired by the Howden-Burdon patent oil-gas system. This furnace, which is illustrated in Fig. 9, is capable of heating upwards of 300 rivets per hour at an oil consumption of 2 gals. per hour. An interesting feature about this furnace is that it is portable, and can be made a self-contained unit, which renders it a profitable proposition for all classes of structural work and shipbuilding.

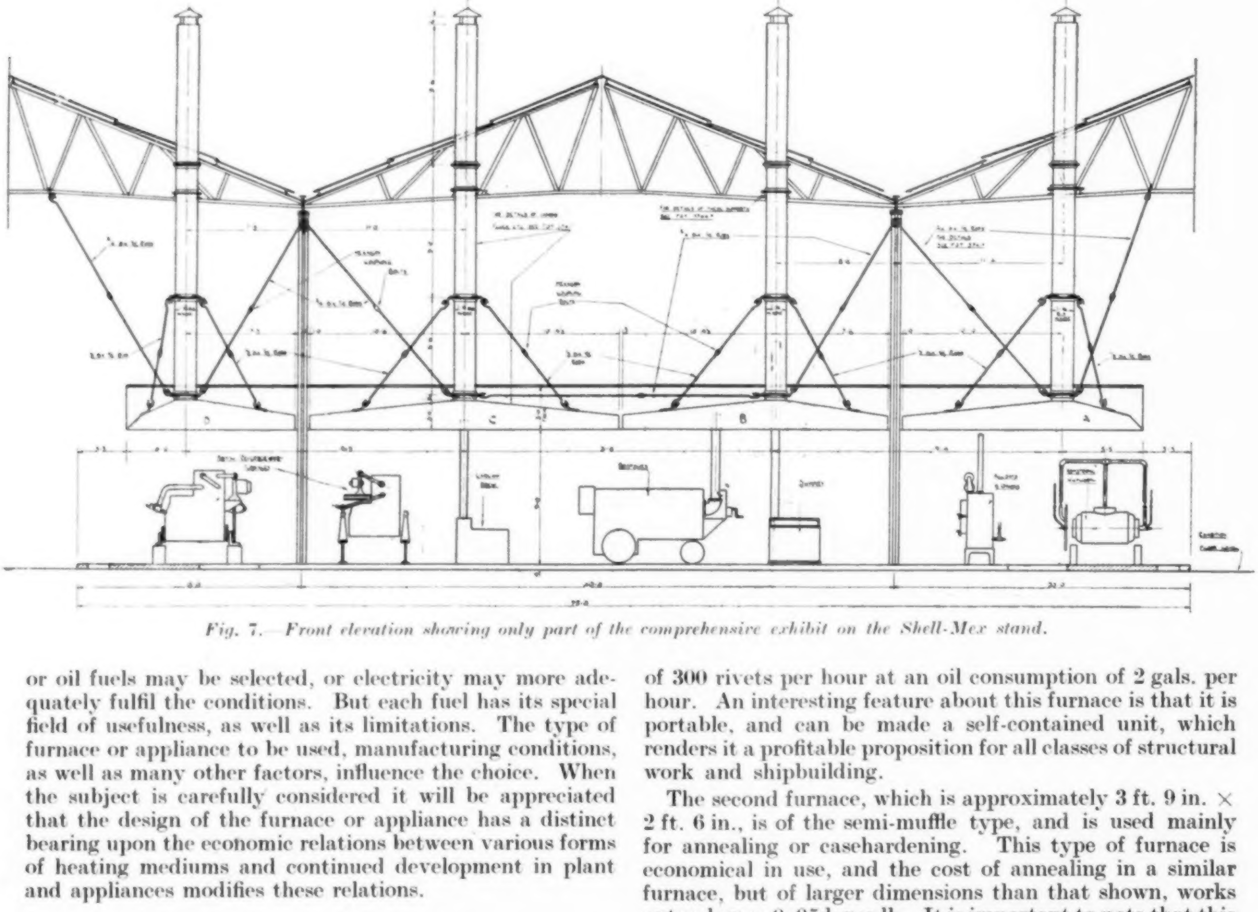


Fig. 7.—Front elevation showing only part of the comprehensive exhibit on the Shell-Mex stand.

The second furnace, which is approximately 3 ft. 9 in. × 2 ft. 6 in., is of the semi-muffle type, and is used mainly for annealing or casehardening. This type of furnace is economical in use, and the cost of annealing in a similar furnace, but of larger dimensions than that shown, works out as low as 0·05d. per lb. It is important to note that this furnace is an under-fired type, and no flame directly impinges on the work. These furnaces are fitted with Foster patent thermo-electric controls, which automatically control the oil supply and maintain constant temperature to ± 3°.

Heating for forging and other forming operations is one of the most important operations in the fabrication of metals. Its influence on subsequent heat-treatment and machining operations has a direct result on the quality of the finished product that cannot be over-estimated. Better control of heat in the forging furnace and uniformity in the temperature of the heated material eliminates many of the difficulties experienced in subsequent heat-treatment.

Investigations into initial heating of this kind have indicated lines along which improved methods and equipment improve the standard of work produced, and the International Furnace Equipment Co., Ltd., show an oil-fired recuperative forging furnace of an improved design.

Fig. 8.—New burner developed by Alldays and Onions.

This type of furnace is being effectively employed in a number of large works. This company also exhibit a super type oil-fired heat-treatment furnace, 3 ft. × 2 ft. × 1 ft., which is fired on the new " International " system of radiant diffusive walls. Both furnaces will be fitted with controls on the primary and secondary air as well as on the oil supply, in order to ensure the maintenance of a predetermined temperature or quality of atmosphere.

Two economical melting furnaces are exhibited on this stand, manufactured by British Reverberatory Furnaces, Ltd. These comprise Sklenar patent oil-fired tilting furnaces; one, the " Midget," of 350 lb. capacity, is designed for melting high-duty grey and white irons, while the other, the " Pigmy," of 160 lb. capacity, is capable of melting a full charge of copper alloys in 25 mins.

The " Midget " furnace for melting grey and white irons, a front elevation of which is shown in Fig. 10, embraces several interesting features. Specially designed to facilitate melting, the oil-burning equipment on this furnace combines the latest practice in low-pressure air atomisation, which will function for long periods and yet give minute control of combustion. The recuperative system incorporated in the design is specially arranged to preheat the air to a high degree.

The " Pigmy " tilting furnace for melting non-ferrous metals, has a remarkably low running cost, and provides for an output of two to three charges of copper alloys or four to five charges of aluminium per hour. Although melting by this furnace is rapid, the patented features incorporated in its design are claimed to safeguard against metallic losses.

The Morgan Crucible Co., Ltd., are showing one of their wide range of patent tilting furnaces. This will be a 600-lb. unit fired by oil fuel, an illustration of which is shown in Fig. 11. Fitted with Salamander crucibles, these furnaces are designed for melting cupro-nickel, bronze, brass, aluminium, and similar non-ferrous metals and alloys, under those conditions best calculated to yield metal free from gas and other contamination, at the desired temperature, without overheating. The charges are melted out of contact with the furnace waste gases, thereby avoiding oxidation losses and risk of defects in the resultant castings. Loss of volatile constituents such as zinc is reduced to a minimum. Brasses containing as much as 40% of zinc are claimed to be capable of being melted in the Morgan furnace with a loss as low as 0·5%. The melting loss with bronze may be as low as 0·25%.

The mixture of oil and air is controlled by means of simple and conveniently placed burner controls. The capacity and flexibility of the burners are such that heats of metals with melting points varying from 500° C. to 1,500° C. or more, can be run in the same unit by merely adjusting the pressure of the burner air supply.

A non-crucible open-flame furnace having a capacity of 3½ cwts. (brass) will be exhibited by Sir W. G. Armstrong Whitworth and Co., Ltd., which will be equipped for demonstration purposes. It is a semi-rotary type of furnace, and represents a recent development for melting non-ferrous metals giving several advantages, of which the most important claimed are economy in operation and the production of superior quality metal.

This furnace, which is shown in actual operation in Fig. 12, is fired through the medium of two burners, one at each end of the furnace barrel. The flame produced does not impinge directly upon the sides of the furnace nor upon the metal, thus reducing wear of the lining and oxidation of the metal to a minimum. The semi-rotary movement of the barrel results in the charge of metal being rolled so as to come into contact with that part of the lining previously exposed to the heat of the flame, and in this way additional heat is induced into the metal.

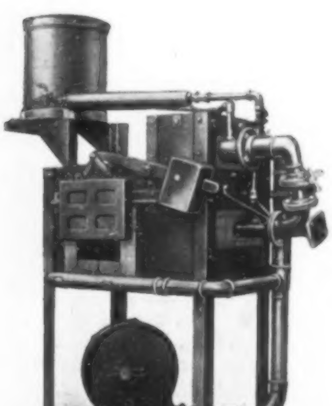


Fig. 9.—Self-contained rivet-heating furnace, by Burdon's, Ltd.

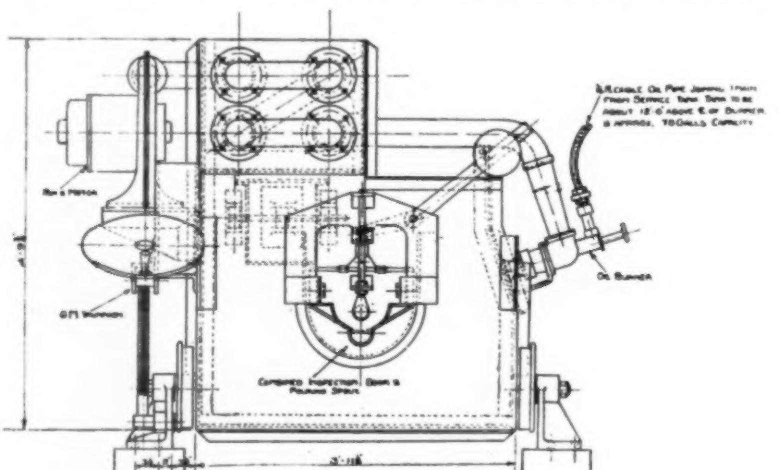


Fig. 10.—Front elevation of " Midget " furnace for melting grey and white irons, by British Reverberatory Furnaces, Ltd.

Manchester Furnaces, Ltd., will be showing examples of their new type of oil burner specially designed for industrial furnace work. This burner represents a great improvement on the older type, giving close control of temperature and

combustion conditions ; shape of flame set should be easily obtained.

Many applications of the "Rotamisor" patent low-pressure air-oil burning equipment are also exhibited. It is shown applied to an "Economic" type boiler front, but is also suitable for industrial and metallurgical furnaces. This equipment, which is manufactured by Combustions, Ltd., consists primarily of a special burner which employs a novel but effective method of atomising the oil. A sectional illustration of a standard model Rotamisor is shown in Fig. 13. This burner produces a very soft gaseous flame, which is claimed to give even heating without the danger of damaging the furnace brickwork, and the system has been selected in many cases where a soft soaking hear is required.

The increasing application of oil fuel and the extent of its field is further illustrated by the range of plant exhibited by the Wallsend Slipway and Engineering Co., Ltd. The oil burners shown may be conveniently classified in the following four groups :—

(1) Low air-pressure burners, in which the oil is atomised by air supplied by a blower working up to pressures of approximately 20 in. w.g., which are used for metal melting, refining, billet heating, bolt and nut making, baking ovens, core-drying stoves, central heating boilers, and numerous other applications.

(2) Burners which use compressed air for atomisation, using pressures up to 50 lb. per sq. in., and possibly more, are used in furnaces in which very high temperatures are required.

(3) Steam-jet burners, in which steam is the atomising agent, which are often used for steam-raising purposes.

(4) Pressure system of oil burning, in which the oil is atomised by what is termed a centrifugal atomiser, which is more generally used for large steam-raising plants.

Another interesting exhibit on this stand will be an Urquhart portable atomising burner for oil fuel, as used in structural work, shipbuilding, and boiler making, for such operations as shrinking and unshrinking, plate and girder bending. One of its interesting features is the length of flame obtainable, from 2 ft. to 5 ft., without smoke and without deposit on the work. The length of flame can be accurately controlled, and will be demonstrated at the Exhibition. Messrs. Swinney Bros., Ltd., will show another application for oil fuel, and will exhibit an oil-fired cooking range of the type usually installed in restaurants, canteens, or on board ships.

A further interesting exhibit is that by Messrs. Laidlaw

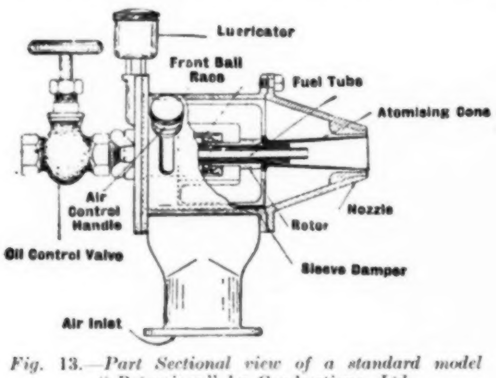


Fig. 13.—Part Sectional view of a standard model "Rotamisor," by Combustions, Ltd.

Drew and Co., showing a high-pressure air burner disposed on a vertical axis, giving a broad saucer-shaped flame, very suitable for the heating of various kinds of pots for melting varnish, lead, etc.

The Application of Town Gas.

During the past twelve months extensive development of the use of gas for industrial purposes has been made in various parts of the country, and, following previous practice, the City of Birmingham Gas Department has arranged for its industrial gas development section to be represented at the Birmingham section of the Fair. In addition to an exhibition of town-gas-fired furnaces and industrial apparatus, the stand will form an advisory bureau on the application of town's gas to industrial

Fig. 12.—Non-crucible open flame oil-fired melting furnace, by Sir W. G. Armstrong Whitworth and Co., Ltd.

processes. The exhibits have been arranged with the co-operation of various manufacturers of gas furnaces and industrial appliances, and will be shown under practical working conditions where possible.

For some years Messrs. Brayshaw Furnaces and Tools, Ltd., have been engaged in experimental work with the object of producing a type of gas-heated furnace which would be efficient from the point of view of fuel consumption and its application to the work in hand, and which would also embody special features allowing work to be handled as expeditiously as possible with a minimum heat loss from the furnace. The "Novopress" furnace, Fig. 14, which is shown on this stand as being representative of

Fig. 11.—600 lb. oil-fired crucible tilting furnace, by Morgan Crucible Co., Ltd.

the firm's products, embodies the features mentioned, being fitted with a specially designed gas and air mixing valve fed with gas and air supplies under complete control. The furnace is of the recuperative type, the recuperators being made in heat-resisting metal.

With the lower prices for town's gas, which are now being offered to manufacturers taking gas in large quantities,

the possibility of extending its use to forging operations is becoming more pronounced. With a view to fostering the demands a forging furnace by Messrs. Davis Furnaces, Ltd., will be exhibited on this stand. This furnace will embody the principles now well known in the Revergen type of furnace made by this Company, in which regeneration of the waste heat is carried out by the change-over system.

Extremely high temperatures are available in this type of furnace, and work is carried out with a minimum amount of scaling. The importance of the last-mentioned part of the forging operation is becoming more and more realised every day, particularly in the case of the alloy steels which are being used so extensively.

One of a number of standard types of combination recuperative furnaces of a comparatively small size, by the Incandescent Heat Co., Ltd., will be exhibited. This furnace, shown in Fig. 15, represents the natural draught type of low-pressure gas-heated furnaces which are available for the general works heat-treatment operations of annealing, normalising, carburising, and re-heating. It will be fitted with automatic control of gas supplies and damper by Messrs. The Foster Instrument Co.

Messrs. Wm. Allday and Co., Ltd., are well-known makers of gas-heated soldering iron stoves, blow-pipes, etc., and are also makers of several interesting furnaces of smaller types. One of the latter is shown on the stand as being suitable for the heating of brass billets for hot-stamping work.

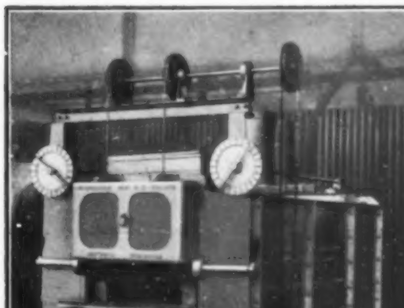


Fig. 15.—Low-pressure gas-heated furnace, by Incandescent Heat Co., Ltd.

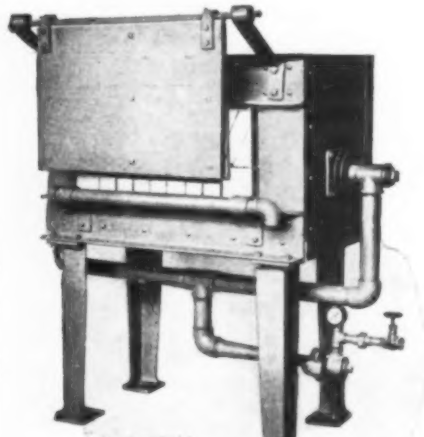


Fig. 16.—Direct forge type furnace, by British Furnaces, Ltd.

Combustors embodying the principles of surface-combustion gas heating, made by The Metropolitan Fuel Co., Ltd., in various forms, have been adapted to many industrial heating processes with success. Up to the present their usefulness has been limited by the fact that it has not been possible to operate the combustors beyond comparatively low temperatures. For some time, however, this Company has carried on experimental work with a view to producing a combustor which would be suitable for very much higher temperatures, and in what is termed their No. 3 Combustor (an example of which is shown on this stand, working on a small furnace suitable for general hardening operations) they are convinced that they have a piece of apparatus which would be of great value in the application of gas to heating processes generally.

A small furnace, Fig. 16, of the direct-forge type is shown by British Furnaces, Ltd., representing the products of British Furnaces, Ltd., which embodies their now generally well-known method of surface combustion heating.

A considerable part of this stand is arranged with testing equipment to illustrate the machines and apparatus

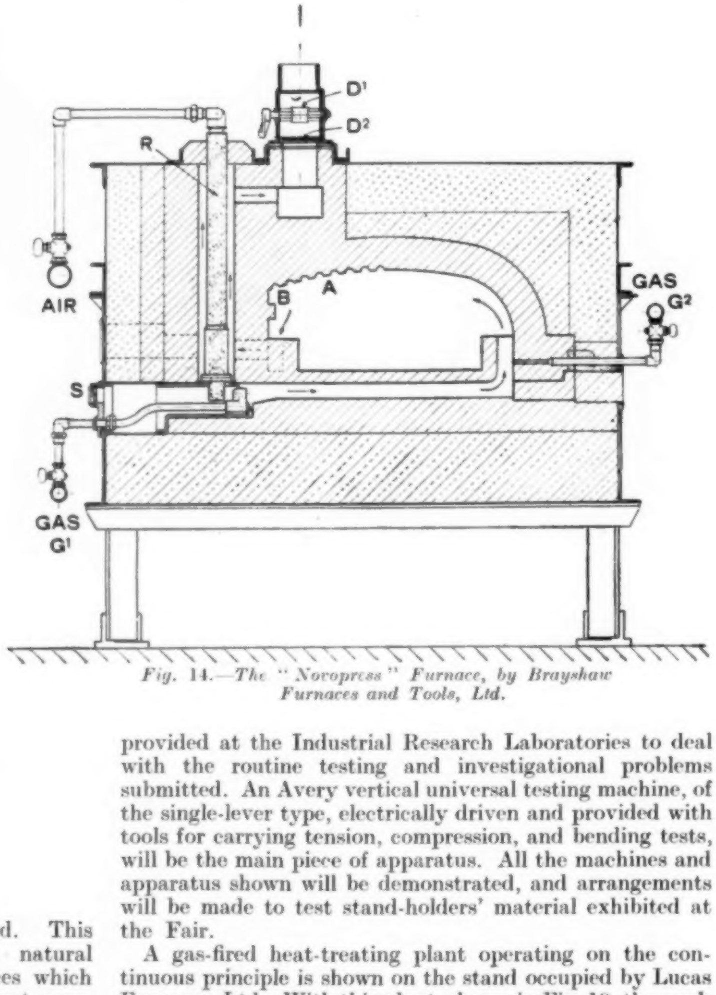


Fig. 14.—The "Noropress" Furnace, by Brayshaw Furnaces and Tools, Ltd.

provided at the Industrial Research Laboratories to deal with the routine testing and investigational problems submitted. An Avery vertical universal testing machine, of the single-lever type, electrically driven and provided with tools for carrying tension, compression, and bending tests, will be the main piece of apparatus. All the machines and apparatus shown will be demonstrated, and arrangements will be made to test stand-holders' material exhibited at the Fair.

A gas-fired heat-treating plant operating on the continuous principle is shown on the stand occupied by Lucas Furnaces, Ltd. With this plant, shown in Fig. 10, the work to be treated is placed in containers having sides and back, but open at the front. The containers are introduced into the heating chamber from a charging table, mechanically. A continuous chain of containers is formed throughout the furnace, so that when a full complement is made up the next one charged causes one to be discharged. At the discharge end of the heating chamber is a development

of the Lucas patents. The discharged container is held on a sloping floor, which is protected from the ill-effects of contact with air by a gas-screen arrangement. The released work falls through the front flue downtake into a chute which is sealed in the quenching tank, and is direct quenched without coming in contact with the air. The quenched work is discharged from the tank mechanically. The empty container is removed and refilled on the charging table. By this method the work is perfectly soaked at a definite temperature, and treated free from scale.

The Application of Electricity.

Substantial progress has been made during recent years in every branch of electrical engineering. The results of continued research and invention, together with steady improvement in design, are reflected by the increasing size, efficiency, and adaptability of electrical apparatus of all kinds. The services rendered by electricity are more numerous, and are discharged more effectively than ever before. Noteworthy advancees have, for instance, been made in the domain of industrial electrical heating, and in this connection the latest insulating products are exhibited.

Of the electric furnaces exhibited, much interest will be centred on those shown by Birmingham Electric Furnaces, Ltd., in view of the acquirement by this firm of the patent rights of the Hayes " Certain Curtain " atmosphere control. Furnaces shown have this feature. Scaling and decarburisation have long been a source of trouble in tool-hardening and other work, and this new patented method affords a simple means of avoiding these troubles. Experience has shown that to get the best results it must be possible to vary the furnace atmosphere according to the material under treatment, and means are provided for effecting this control and actually indicating the composition of the furnace atmosphere. The correct atmosphere is obtained by burning instantly-measured quantities of coal gas and air in a special mixing or combustion chamber under the vestibule, and emitting the products of combustion through a slot extending the full width of the hearth, thus effectively screening the interior of the furnace from the outside air.

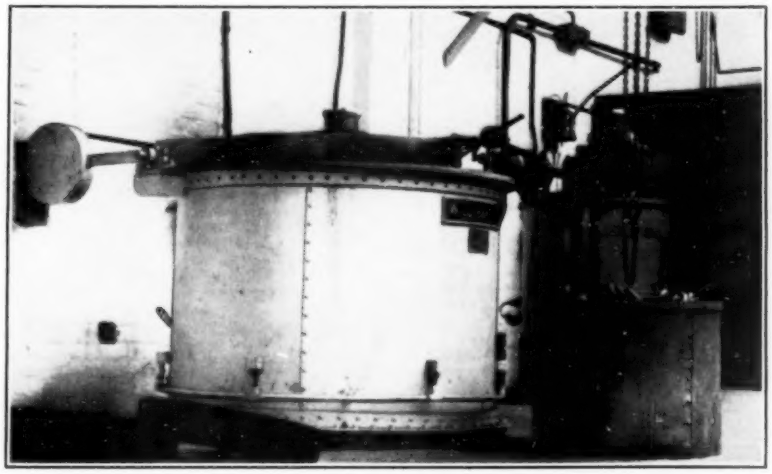


Fig. 17.—Electro-magnetic hardening, by Wild-Barfield Electric Furnaces, Ltd.

Two furnaces designed for tool-room work, and fitted with this patent gas curtain, are shown, one being designed for pre-heating high-speed tool steel and re-heating general carbon tool steel work up to 1,000° C., and the other, capable of being operated up to 1,400° C. for hardening high-speed tool steel. The first of these (Fig. 19) is a 16-kw. model S.R.A. 20 " Birlec " furnace, with hearth 27 in. long × 12 in. wide, which is one of an entirely new series of furnaces for tool-room and similar work up to 1,000° C. The heating elements consist of very robust nickel-chromium strip located in the sides, roof, and under the hearth. Special provision is made for the easy renewal of the elements through the front, without detracting from the efficiency of the furnace.

The high-speed steel furnace is a 20-kw. model H.S. 20 " Birlec " furnace, with hearth 12 in. long × 8 in. wide (Fig. 18), and also fitted with the " Certain Curtain " atmosphere control. The heating elements are " Globars," which extend from front to back along the two sides of the furnace.

Fig. 18.—Electric heat-treating furnace, fitted with " Certain Curtain " Control, by Birmingham Electric Furnaces, Ltd.

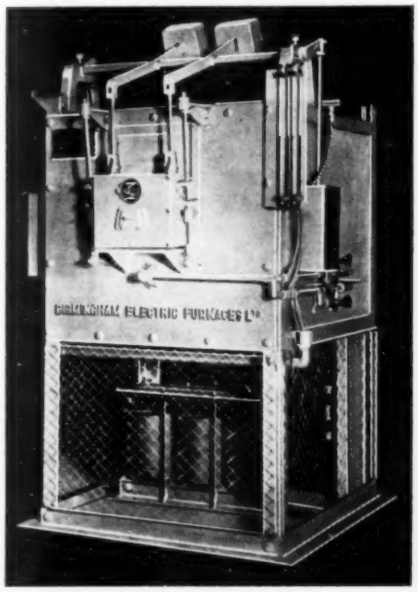
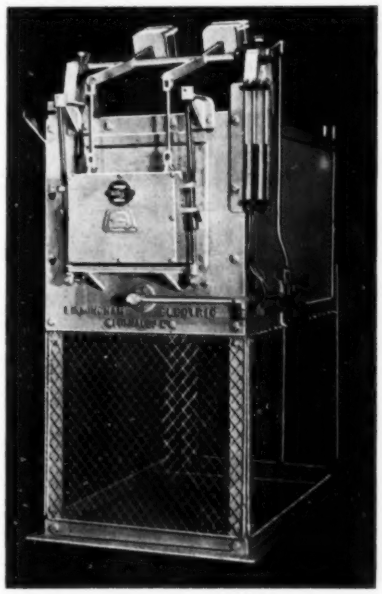


Fig. 19.—High-speed-steel furnaces by Birmingham Electric Furnaces, Ltd.



Amongst other furnaces exhibited by this firm a patent high-velocity forced-draught tempering furnace of the vertical type is shown, having a maximum rating of 12 kw. Of centrifugal type this furnace is operated at a high speed, and is enclosed in a scientifically designed volute casing. The use of such a casing doubles the efficiency of the fan, and this, together with the high speed used, causes the air to circulate with a speed of no less than 40 miles an hour. The higher the speed, the quicker

the heat transference and the more uniform the temperature. It is thus obvious that this exceptionally high speed of air flow is accompanied by increased uniformity and rate of heating. After the air has passed over the heating elements and the control thermocouple, it is tangentially deflected into the main chamber, so as to set up eddy currents round the charge.

Both vertical and horizontal types of electro-magnetic hardening furnaces will be exhibited by Wild-Barfield Electric Furnaces, Ltd., which will be in operation, one of which is shown in Fig. 17. The advantage of this type of furnace is the indication given to the operator of the exact moment when tools or parts in carbon - carburised and low alloy steels should be quenched. These furnaces are operated successfully not only in this country, but throughout the world. The new Wild-Barfield pit-type furnace, with forced air circulation will be in daily use for tempering springs, so that visitors will have an opportunity of witnessing modern operations of this kind.

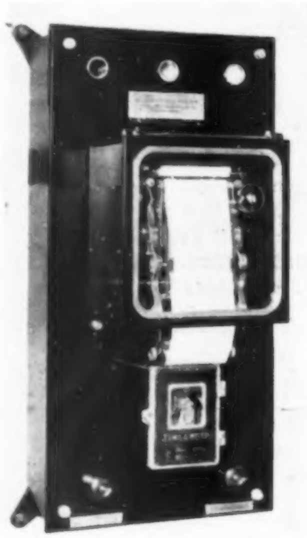


Fig. 20.
The Wild-Barfield-Foster charge progress recorder.

The Wild - Barfield-Foster charge progress recorder shown in Fig. 20 is used in conjunction with the furnace, and not only controls and records the furnace temperature, but records also the progress of the charge itself, notifying the operator when the charge being tempered has reached the desired temperature. These equipments are in use, not only for tempering, but also for heat-treatment of aluminium alloys and other material, in the heat-treatment of which uniformity and precise control of temperature are essential.

Amongst other exhibits on this stand will be a high-speed steel-hardening equipment, small laboratory muffles, and a Vickers pyramid diamond hardness testing machine. In addition, a section of a larger box-type heat-treatment

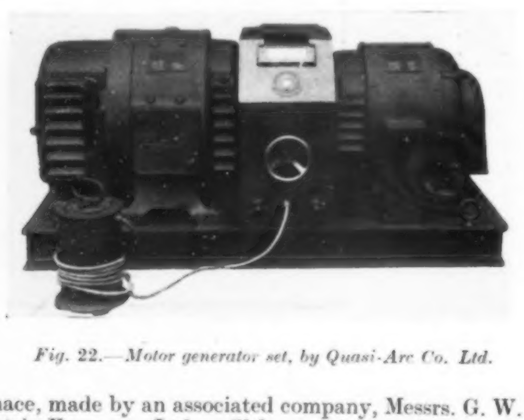


Fig. 22.—Motor generator set, by Quasi-Arc Co. Ltd.

furnace, made by an associated company, Messrs. G. W. B. Electric Furnaces, Ltd., will be on view, and visitors will be able to see the unique features which have made these furnaces popular. This company is also exhibiting various grades of Eternite casehardening compound, which will be of interest.

Welding Processes and Equipment.

The welding and cutting of metals by gas or electricity have made remarkable progress during recent years; development in the application of these processes, however, only been possible because it has been appreciated that has high purity and good quality materials are essential to success. In addition to first-class welding materials, the importance of well-designed and soundly constructed welding and cutting equipment cannot be overestimated. In view of the gradual developments, improved technique, and wider field of application, it is not surprising that the welding industry will be well represented at the Birmingham section. Prominent among the exhibitors of materials and equipment for welding will be the British Oxygen Co., Ltd., Murex Welding Processes, Ltd., and the Quasi-Arc Co., Ltd., pioneers in the development of welding processes that continue to maintain a position in the forefront by reason of research and experimental work which is maintained on a progressive scale.

The British Oxygen Co. are exhibiting and demonstrating oxy-acetylene welding and cutting equipment, oxygen cutting machines, and electric welding equipment. Apart from oxy-acetylene welding and cutting equipment, blowpipes will be displayed for other purposes, such as oxy-acetylene, oxy-coal-gas, oxy-hydrogen, and air hydrogen

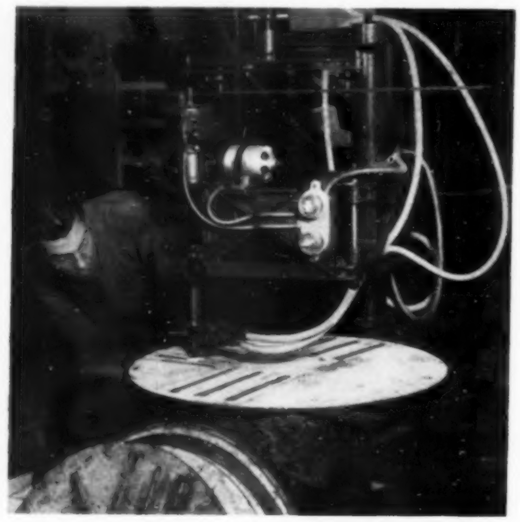


Fig. 21.—Oxygen cutting machine, by British Oxygen Co., Ltd.

lead burning; air acetylene heating; brazing, soldering, or paint burning; oxy-coal-gas blowpipes for gold and platinum melting; glass and quartz working, etc. Welding rods and fluxes for all metals will be available, and demonstrations of welding will be given in stainless steel, copper, aluminium, and other metals and alloys. Not the least interesting feature of this exhibit will be the demonstration of oxygen cutting machines. Two sizes of machines for cutting irregular shaped articles, from steel plate or forgings, similar to those shown in Figs. 1 and 21, will be shown, as well as a variety of machines for cutting steel sections of various kinds. An arc welding plant, a spot welder, and also an electric rivet heater, will be demonstrated, and some interesting specimens of work exhibited, including a display of electrically welded specimens which have been tested by Lloyds.

The Quasi-Arc Co. will exhibit several of their standard types of welding sets, examples of welded construction, and samples of each of their range of patent electrodes. Their stand will contain welding bays supplied with current from one of their standard three-operator alternating current transformer welding sets. This set will be in operation on the stand, and demonstrations of welding will be given to interested visitors. Their special "railway type"

petrol-engine-driven set, portable transformer, and motor generator sets will also be shown. The single-operator, portable motor generator, and "railway type" sets will be of particular interest, the former as it is of new design and incorporates several unique features, and the latter as it was the first set of this type to be placed on the market. The examples of welded construction to be shown will comprise many types of welded joints, etc., such as are used in ships, bridge girders, oil tanks, and so forth. Other interesting welded exhibits will also be shown.

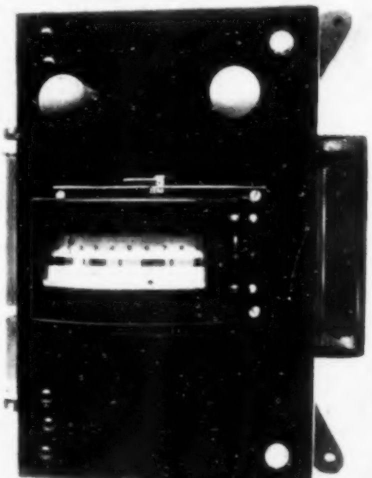


Fig. 23. Temperature controller, by Foster Instrument Co.

Fig. 25. Section cutting machine, by Greenwood and Batley, Ltd.

Among the many spot welding machines which will be exhibited at the British Electric Welding Machines, Ltd., are several machines which incorporate the "Stronghold" automatic control principle. This control is worked electrically, and once set will automatically produce a neat and uniformly reliable weld every time the operator depresses the pedal, quite irrespective of the "dwell" of the operator's foot upon the pedal, or the speed at which he depresses the pedal. The principle employed is by current-limiting device, acting through time-lag gear, which by relay circuit automatically trips the switch immediately the weld is completed. These machines are specially suitable for rapid production, and will deal with all usual spot welding propositions, and in addition render the welding of coated sheets (such as galvanised tinned material), a reliable proposition under repetition conditions. This firm is also exhibiting a larger spot welding machine of 20 kw. rating, specially designed for coach panel work, and also a number of butt welding machines.

Temperature Control Apparatus.

Fig. 24.—Distance Thermometer, by Cambridge Instrument Co.

A typical indicating temperature controller for electric, gas, and oil furnaces is illustrated in Fig. 23. It is exhibited by the Foster Instrument Co., and consists of an edgewise indicator which functions in the normal way with a thermocouple, to indicate the temperature of the furnace. This indicator has mounted below the pointer "high" and "low" contacts which are adjustable to the desired temperature, the pointer being periodically depressed by a presser bar, which is actuated by a motor and depression mechanism situated behind the panel. The instrument works on the "hit-or-miss" principle, the closing of either of the contacts serving to operate a sealed mercury switch, which, in turn, serves to control the motor-driven or solenoid valves controlling the fuel supply to the furnace when oil or gas is used, or, in the case of an electric furnace would control the contactor panel. In the case of furnaces using gas or oil the control valves are of such design that a continuous supply of fuel is being fed to the furnace, just sufficient to bring it to within about 20° of the required temperature, and the controller operates the valve to allow an additional amount of fuel to pass sufficient to bring the temperature above that desired.

Cambridge Instrument Co., Ltd., also are exhibiting a number of special features, and attention is directed to one of the newer types of distance thermometers for air temperatures. This is illustrated in Fig. 24. It is of the rosette form, and consists simply of the covered platinum wires drawn into copper sleeving and wound into a spiral, giving virtually a very large surface of bulb for exposure to the air temperature, with the result that a quick-acting thermometer is obtained. Both the above firms are exhibiting a complete range of industrial instruments for the measurement and control of heat, including thermocouple, optical, and radiation pyrometers, electrical distance thermometers, etc.

Patent Section Cutting Materials.

Amongst the many exhibits by Greenwood and Batley, Ltd., is a section and mitre cutting machine, patented by Mr. F. R. Hall. This machine, which is shown in Fig. 25, is of the semi-rotary type and will cut angles $2\frac{1}{2}$ in. $\times$ $2\frac{1}{2}$ in. $\times$ $\frac{1}{2}$ in. It is claimed to leave a square finish to the cut,

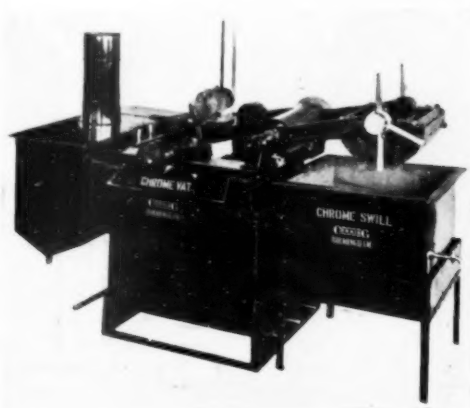


Fig. 26.—The application of a chrome-plating ladle by W. Canning and Co., Ltd.

and obviates the necessity for grinding. The moving blade, which is attached to a slide, is operated by a cam motion, the action being first to grip the section against a fixed blade; during further movement of the cam the moving blade is partially rotated, therefore shearing the section while supported by the stationary blade. The machine is arranged for direct drive from lineshaft.

The Deposition of Metals.

Chrome-plating has now passed the experimental stage and is no more difficult to carry out than any other form of electro-deposition; it is very necessary, however, to install the right equipment designed on the right lines to exhaust the fumes without obstructing the economical working of the plant. A model vat for chrome-plating will be exhibited by W. Canning and Co., Ltd., in which the solution tank is arranged for steam heating, and complete sets of cathode and anode rods and anodes are shown.

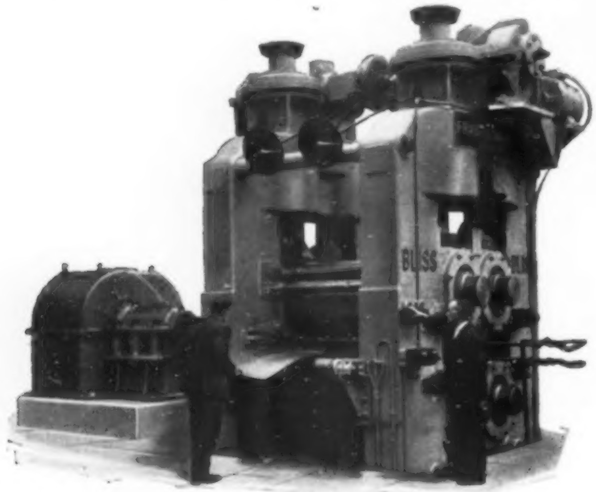


Fig. 27.—A "Cluster" mill, by Fraser and Chalmers Eng. Works.

An interesting development in the deposition of chromium is a chrome-plating cradle, shown by the same Company, for handling small articles which will roll. No wiring-up of the articles is necessary, and the output is practically continuous. This machine is illustrated in Fig. 26. Fully automatic plants are now used in the deposition of nickel, copper, brass, silver, cadmium, and zinc, and, in fact, may

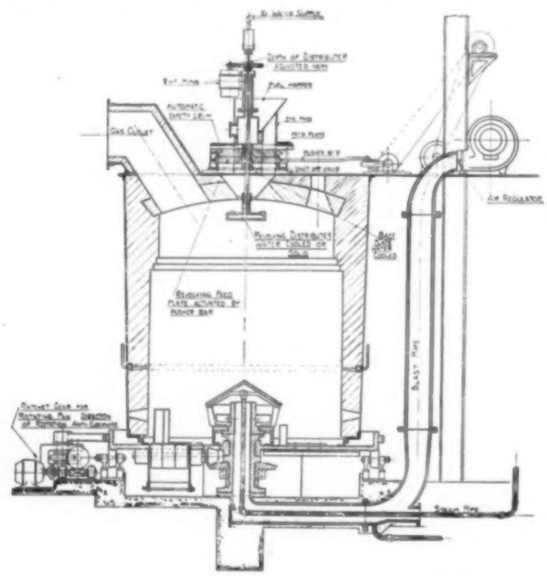


Fig. 28.—A new and improved gas producer.

be applied for the deposition of any metal when the quantity of work warrants the outlay. They are also made to deposit two metals in their proper sequence. Visitors will find much of interest in these exhibits.

A Cluster Rolling Mill.

A wide selection of plant manufactured by Fraser and Chalmers Engineering Works (The General Electric Co., Ltd.) will be of considerable interest.

A "Bliss" cluster rolling mill, one of the smallest of the type made, will draw attention to these highly perfected precision machines (Fig. 27). The use of roller bearings with large-diameter backing rolls and small working rolls in these machines enables the rolling pressures and reductions to be increased, although the power consumption remains low. Fewer passes are required, resulting in increased output, and sheets up to 50 in. wide can be cold rolled with the advantages of ductility, even gauge, and high finish.

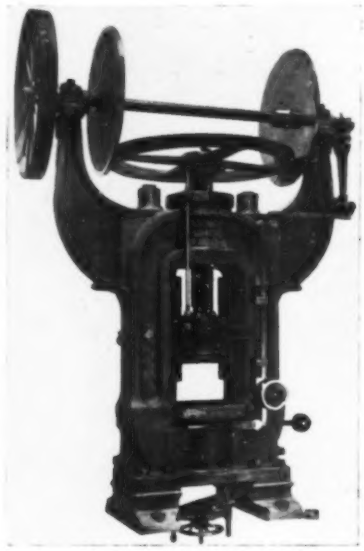


Fig. 29.—Power-percussion screw press of 125 tons capacity, by John Hands and Sons, Ltd.

In addition, conveyers and screening plant will be important features. Most of the machines will be in operation, being driven by "Witton" squirrel cage motors with direct-to-line contactor starters, the motors and control gear being the products of the G.E.C. Engineering Works at Witton.

The Broughton-Hadlington Gas Producer.

A new and improved working model of the Broughton-Hadlington Gas Producer will be exhibited by the District Iron and Steel Co., Ltd. In this new model (Fig. 28) a fuel by-pass with a reversible gas-tight valve is incorporated, which enables the producer to be fed by hand in case of any breakdown of machinery or failure of electric-current supply. Another feature is the provision of a special spring in the pusher arm, the spring of which is brought into action should any foreign matter in the fuel gag the feed-drum; the breakages are thus avoided. There has also been installed, in place of the cross-shaft and bevel drive, an independent drive by a half-horse power vertical motor to the spreader shaft, and the revolving spreader itself is now made of solid steel, of specially high heat-resisting qualities, in place of a water-cooled hollow spreader.

This Company will also exhibit rolled steel goods, such as tubes, angles, light-railway sleepers, etc., and in the tube section the exhibits will include all designs of bedstead ends, as used in metallic bedsteads, steel flush pipes, motor-car exhaust pipes, etc.

Power Presses.

A wide variety of power presses will be exhibited, among which may be mentioned the manufactures of John Hands and Sons, Ltd., and Hollings and Guest, Ltd., now amalgamated. A power percussion screw press will be shown having a capacity to deliver a blow of 125 tons. This machine, illustrated in Fig. 29, will be operating. Driven by electric motor, the power is transmitted to the dies through a friction drive in the form of friction discs mounted on a revolving shaft, which are used to give motion to the flywheel, by which sufficient energy is transmitted to deliver to the dies the maximum working pressure. Several other presses of interest include a large double-sided geared blanking press, which represents one of a range of presses made from 40 to 500 tons capacity.

Several hydraulic presses are exhibited by Hollings and Guest, a notable machine being a four-column press fitted with three steel hot-plates, giving two daylights, specially designed for the manufacture of artificial horn, fibre, bakelite mouldings, and insulating materials of all kinds.

METALLURGIA

The British Journal of Metals

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Australia	25/–	Belgium	Belgas. 43.60	Norway	Kr. 22.80
New Zealand	25/–	Italy	Lit. 116.45	Sweden	Kr. 22.80
India	Rs. 17	Holland	Fls. 15.13	Finland	F.M. 245
United States of America	$6.10	Spain	Pes. 43.20	Japan	Yen 12.65
Mexico	$12.70	Switzerland	Fcs. 31.50		
Argentine	Gold $6.50	Czechoslovakia	C.K. 206.25		
Germany	R.M. 25.50	Jugoslavia	Din. 345		
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METALLURGIA
THE BRITISH JOURNAL OF METALS.

The Tariff and Exports.

After a strenuous political fight, lasting many years, Britain ceases to be a free trade country. This is the result of the Imports Duties Bill, 1932, recently passed, which authorises the imposition, from March 1, of a general duty of 10% *ad valorem* on all imports except goods already dutiable and others that are placed on the free list, particularly raw materials. Thus the repeated demands of industry will in a measure be met. In its present form, however, it is not surprising that many manufacturers are disappointed. Primarily, it is a tariff which has been imposed for revenue purposes rather than as a benefit to industry, but much has been accomplished in making a beginning with this new policy, and a Tariff Advisory Committee will recommend adjustments that will be necessary. Provision is made for the addition of goods to the free list, but not within six months of the passage of the Act. This will give the Committee reasonable time in which to clear off the urgent work of recommending new duties and to appreciate the operations of the free list. Probably the greatest surprise in the Bill is a clause which relieves from duty any goods which are consigned direct to a registered shipbuilding yard for use in the building, repairing, or refitting of ships. The Commissioners can allow goods to be imported free for such work and also allow a complete drawback of duty on similar goods imported to a shipyard through any ports elsewhere in the country. This will satisfy some shipbuilders who consider that the keen competition prevailing in this industry is such that a free market for materials is desirable. Except in this special instance all steel imports will be subject to the general tariff.

The success of the new tariff policy will depend very largely on the ability of each individual member of the Committee appointed. They will need to be familiar with the operation of tariffs in other countries, so that advantageous methods may be adopted to restore trade balance. The flat rate in itself, although useful for revenue purposes, is useless as a protection to many industries. Particularly is this true of the iron and steel industry, and early consideration will, we believe, be given to it by the Committee with the object of making further adjustments that will be more adequate in restoring this basic industry to a position commensurate with its importance.

A number of clauses in the Bill deal with Imperial preference. Thus, for instance, no duties are to come into force on goods from Dominions or Colonies, or from territories where the mandate is exercised by a Dominion, until November 15, 1932, or at a later date which Parliament may decide. At any time after November 1, Parliament, in the light of the Ottawa Conference, may enact that the general duties shall not be chargeable against Dominion produce or manufactures, or shall only be charged at a reduced rate. It will thus be seen that the application of duties to the Dominions is contingent upon the reception of the British advances to be made at Ottawa.

There can be no doubt that this new policy will have considerable influence in helping industry to develop the home market, and there are many signs that it will cause many foreign firms to make arrangements to manufacture in this country. It should not be overlooked, however, that although every effort should be made to develop our own resources, we cannot live in isolation, we must maintain overseas trade. After all, one of the greatest industrial troubles at the present time is that there are insufficient markets to absorb the manufactures capable of being produced. In many industries there is an excess of manufacturing plant which involves a waste of capital and an increase on the cost of manufactured articles, and since the restoration of normal trade will only be achieved by producing the goods wanted at the lowest price, it will be necessary either to increase the markets or get rid of the unproductive plant. Much has been done in discarding old plant, industries have been reorganised and modernised, but while much remains to be done, there is greater need for the extension of markets abroad.

It is in increasing the overseas markets that industry stands to benefit most, and the new policy offers a basis for profitable bargaining. Britain must have imports, and there is no reason why their value should not be balanced by exports. It is true, of course, that the potentialities of Empire trading have not yet been fully realised, but while every endeavour should be made to improve trade with the Dominions, no possible market should be omitted.

To be successful in overseas markets, however, industry must have an effective marketing policy. The keen character of competition has rendered extensive market research imperative, and in searching for new openings manufacturers and exporters should avail themselves of every service which can help in this direction. The Department of Overseas Trade was formed for this specific purpose, and any United Kingdom firm, large or small, interested in the development of export trade, should extract the fullest possible benefit from the services placed at his disposal. The extent to which the Department of Overseas Trade can be of assistance is not generally realised, nor is it appreciated that little or no cost is involved. Adopting a policy of " assistance without interference," this Department, which controls a network of representatives all over the world, places at the disposal of traders a centralised organisation constantly on the alert for every opportunity to benefit British trade. The expansion of the export market is long overdue, but competition is keen, and the manufacturer who wishes to outstrip his competitors must study the market and his customers.

The British Industries Fair, which opens on February 22, to which reference is made elsewhere in this issue, is organised by the Department of Overseas Trade. The object of this Fair is to bring together as many as possible potential buyers, at home or overseas, and a corresponding body of British manufacturers ready to supply their needs, and the prospects of good business resulting from this Exhibition are very bright. Two factors likely to influence many foreign buyers are the depreciated currency and the new tariff policy. Recent variations in the monetary exchanges have made possible purchases from British manufacturers by representatives of several foreign countries, who, in recent years, have been unable to buy in this country, and it is confidently anticipated that many orders will be placed on this account. The threat of higher import tariffs is also likely to encourage attendance at the Fair of representatives of those foreign countries that have in the past found Britain a profitable market. The desire for compromise in the adjustment of tariffs will undoubtedly be manifest, which should benefit British industry.

Large Electric Furnace Installations

By A. Glynne Lobley, M.Sc.

Part I.—Annealing

The Electric Furnace Company, Salem, Ohio, U.S.A., whose experience in resistance type electric furnaces covers more than 20 years, are pioneers in the design of large mechanically operated electric furnaces, which have been installed to handle products of widely different types. It is thought that many readers in this country may be interested in them as these designs and the experience in building and operating the furnaces are now, by recent agreement with a British firm—Messrs. Birmingham Electric Furnaces Ltd.—available on this side.

DURING the "boom" years very many large electric furnaces were installed in the United States, and most of these early mechanically-operated electric furnaces were evolved to meet the demand in mass-production automobile plants. That is to say, they are mostly required in connection with the heat-treatment

Fig. 1.—A 375-kw. annealing furnace, consisting of two heating and one cooling chamber and cross-transfer car, handling 700 tons of steel castings per month.

of steel. The heat-treatment processes required comprise annealing, normalising, carburising, forging, and tempering. On the other hand, the demands of non-ferrous industries, with the exception of the heat-treatment of aluminium alloys, are restricted to annealing. Annealing, then, is a process made use of both in ferrous and non-ferrous industries, and for this reason may well be dealt with first.

Annealing as Required for Non-Ferrous Metals.

Referring first to non-ferrous metals, particularly brass and copper, there are two annealing treatments ordinarily required. The first of these is the annealing between passes which is given to permit subsequent rolling or drawing. These metals are ordinarily cold-rolled, and after a number of passes they become too hard for further rolling without cracking of the metal. Annealing softens the metal, and permits the additional reduction which is desired.

After rolling to the final size, the use for which the metal is intended will determine the desired hardness. This hardness is secured by the finish anneal, which may be carried on at a temperature much lower than the annealing between passes. In the case of condenser tubes, the only purpose is to relieve the internal stresses to such an extent that the metal will not crack in service. Treatments ranging from this low temperature annealing to one which produces very soft material will be used for various processes.

In many non-ferrous annealing processes, the accuracy with which the temperature is regulated is, if anything, of more importance than in the case of steel. Comparatively small changes in the annealing temperature will often produce very considerable differences in the physical condition of the metal. It is on account of this fact that the electric furnace is now finding so many applications in non-ferrous industry, for with no other type of furnace can such uniformity of results be obtained.

Annealing as Required for Steel.

In annealing steel, other objects apart from the removal of work hardness must be sought. A steel casting, as it comes from the mould, is thoroughly unsuitable for many purposes. The metal has cooled from a molten state, where the temperature is far above the critical range, and is, therefore, coarsely crystalline and lacking in the toughness which is associated with a fine grain structure. Uneven rates of cooling cause internal stresses which might produce failure even under moderate load, and, further, the rapid cooling often leaves the casting in too hard a condition for machining.

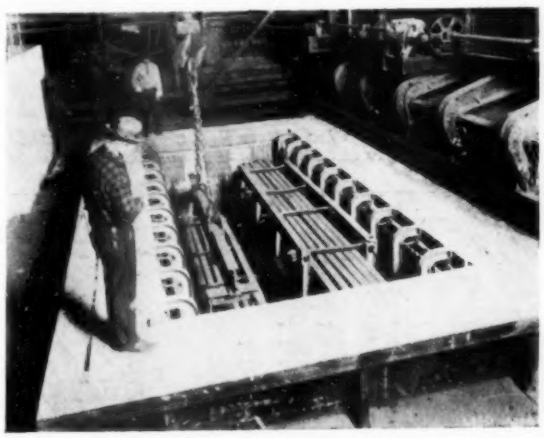


Fig. 2.—Lowering a 20-ton cradle of steel bars into one of five 850-kw. pit-type furnaces used for annealing alloy steel bars.

Such materials are annealed by re-heating to a temperature just above the critical range, which brings about re-crystallisation. If heated much above the critical range, grain growth will occur, so that the aim is to heat just high

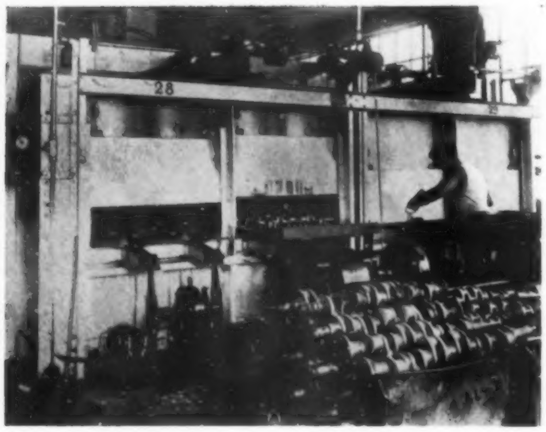


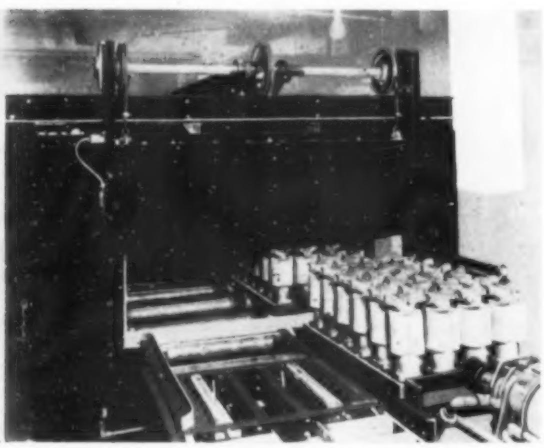
Fig. 3.—A 320-kw. double chamber recuperative tempering furnace handling crankshafts. Note automatic pusher and ejecting mechanism.

enough, and to hold it just long enough to make the transformation complete. If the casting contains sufficient carbon, it may be hardened by cooling rapidly, as in water, or made relatively soft by very slow cooling. Intermediate rates of cooling can be determined which will give the best combination of hardness and toughness for any given purpose.

Steel which has been mechanically worked while hot, such as rolled bars or forgings, possesses a much better structure than that of a casting or ingot. As, however, it is very difficult to control the temperature at which the steel is finished, or the rate of cooling from this temperature, it is often necessary to anneal bars or forgings before machining, or before the final heat-treatment. Rolled steel is annealed to produce softness which will permit cold heading, stamping, or other forming, to allow free machining, or to put it in the best condition for most effective final heat-treatment. Forgings are annealed to refine the grain structure, take out internal stresses, and also, of course, with a view towards satisfactory machining, and later heat-treatment. Proper annealing of forgings considerably increases the speed with which subsequent machining may be carried out, and, moreover, minimises, or even eliminates the distortion which otherwise is very liable to occur during the subsequent hardening operations.

In addition, annealing often has to be carried out in the manufacture of cold-pressed or stamped objects, as in similar cases in non-ferrous industries.

Fig. 4.—Front view of a return flow recuperative annealing furnace for handling air-cooled cylinders.



Types of Furnaces for Annealing Purposes.

In the early days of electric furnaces, many car-type units were built, and this type is still the most convenient and adaptable furnace in the steel foundry, and finds a great deal of use handling rolled bars, forgings, etc., in alloy steel mills. In certain cases, separate chambers are added for cooling purposes, or means provided for forced cooling of the furnaces. The cars or bogies are, of course, motor-driven, and where more than one furnace is installed, motor-driven transveyors may be provided. Such an installation is illustrated in Fig. 1. Nearly all the steel foundries in the States making very high-grade castings have electric annealing equipment. One important alloy steel mill in which all annealing and normalising is carried out in electric furnaces, has a total connected load of over 6,000 kw. for these purposes alone. This plant manufactures bearing steel in the form of bars and tubes, and also forging steels for automobile use. The bearing steels are of the high-carbon chromium type, which requires a very long annealing cycle to secure the necessary structure. This material is handled in a set of five 850 kw. pit-type furnaces (one of which is illustrated in Fig. 2), which are of interest in differing considerably from many others so far built. They are designed to accommodate bars or tubes up to 20 ft. in length, and have an effective loading space 7 ft. wide × 6 ft. deep. It is possible to load about 100 tons of bar steel in each of these furnaces at one time, although it has been found that the most economical

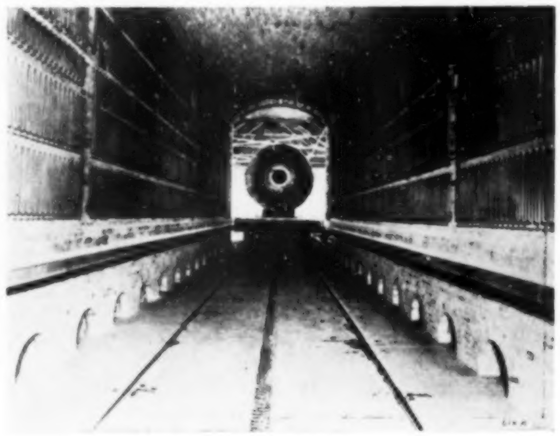


Fig. 5.—Interior view of 3,000-kw. furnace for annealing large oil stills and pressure vessels. This furnace is 65 ft. long, and contains over 1½ miles of extra heavy section heating elements.

charge is somewhat smaller. The duration of the heat is usually from 50 to 70 hours, the average production capacity, therefore, being in the neighbourhood of 25 tons per day per furnace. Special features had to be developed for pit-type furnaces of such large size. It was necessary to design a 40-ton gantry crane for handling the covers, and to work out a system of forced cooling in order to keep down the annealing cycle to a minimum. The cooling system which is used furnishes air-blast cooling, but without direct exposure of the heated steel to oxidising conditions.

Continuous Normalising.

In the same department there are also two large continuous normalising furnaces which handle either bars or tubes up to 5 in. diameter. One of these is rated at about 700 kw., and can produce 3½ tons per hour, while the other, rated at 1,000 kw., can deal with 5 to 6 tons per hour.

The method of handling the material through these normalising furnaces is somewhat unusual. The 700 kw. furnace will handle bars or tubes up to 20 ft. long, the largest bars weighing nearly 1,500 lb. each. The furnace

is rectangular, having one dimension equal to the length of the bars, and the other equal to the space necessary to hold $2\frac{1}{2}$ to 3 hours' production. Across the furnace run a number of rails, which carry cylindrical shoes. These shoes are pushed through one side of the furnace by heavy motor-driven pushers, and are discharged theough the opposite side wall. The bars are charged into the chamber endwise through a small door at one corner, are then carried sideways progressively across the furnace, on the carrying shoes, and finally are pushed out endwise through a small discharge door, diagonally opposite to the charging door. When outside the furnace they are received on a roller table provided with a manipulator for placing the bars on a cooling bed.

In most annealing operations it is not essential to be able to control the rate of cooling, but it is usually preferable to have a consistent cooling rate. In those cases where there is a constant flow of material, recuperative type furnaces can be used, and have the lowest operating cost. Sometimes, however, it is necessary to be able to cool the material through a definite time cycle, and then it is not usually convenient to employ recuperative methods. An interesting example of this is in the preparation of transmission gear forgings made of chromium or chrome-vanadium steel, which gives an excellent combination of hardness and toughness. In order to machine these steels satisfactorily and quickly it is necessary to produce a

Fig. 6.—Battery of thirty-two 140-kw. double-ended furnaces for heat-treating forgings.

structure of intermediate hardness which can only be secured by a very close control of the heating and cooling cycle. This is carried out in a pusher-type furnace having a large number of independently controlled heating and cooling zones. The forgings are carried through the furnace on alloy pans, each chamber measuring about 4 ft. 0 in. wide by 45 ft. 0 in. long, and having a capacity of approximately $1\frac{1}{4}$ tons per hour.

The annealing cycle consists of heating to approximately 1,600° F. (870° C.) as rapidly as possible, holding until thoroughly equalised, then cooling rapidly to about 1,400° F. (760° C.). This cooling is accomplished by means of a forced air draught under automatic temperature control. The temperature is maintained at 1,400° F. (760° C.) until equalised, then cooled slowly through the remainder of the furnace to about 1,000° F. (550° C.), the total time cycle being nearly 9 hours. Even though each zone of this furnace is separately controlled, checks of the actual time cycle the material is undergoing are taken at frequent intervals by means of a flexible thermocouple equal to the length of the furnace, and which is carried through with the charge.

The result of this treatment is to produce a structure which is considerably harder than the fully annealed steel. If the forgings are too soft, they will tear when machining,

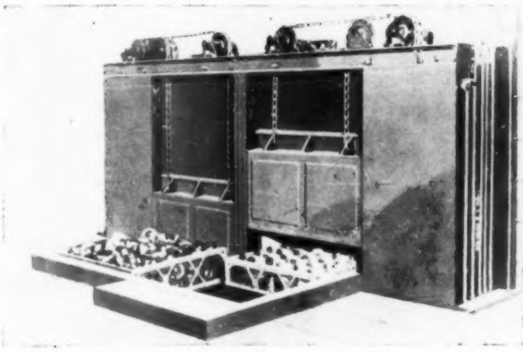


Fig. 7.—180-kw. return flow recuperative type brass annealing furnace capable of handling 2 tons per hour.

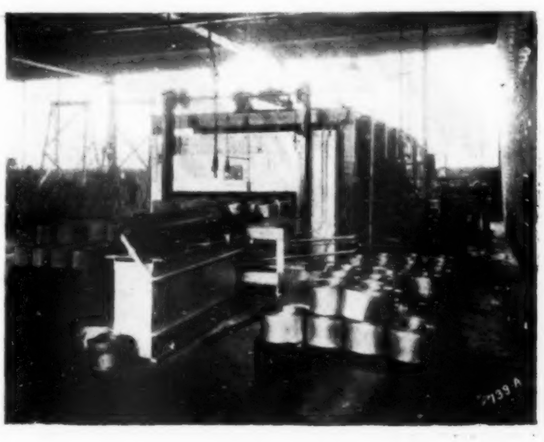
and it will be impossible to secure a clean tooth surface. Any roughness in the gear teeth will result in pitting and excessive wear, as well as noisy operation when the gears are put in service. On the other hand, if the steel is too hard, the machining rate suffers and the life of tools is unsatisfactory.

Counterflow Furnaces.

The principle of the counterflow recuperative type of furnace is probably familiar now to most furnace users. The important feature is that, instead of the heat in the outgoing charge being wasted, it is used to preheat the ingoing charge. This can be done by building a long, tunnel-shaped furnace, with two rows of containers passing through side by side in opposite directions, with the heating chamber located centrally in the tunnel, the end portions then being recuperative or heat exchange chambers. A furnace of this type is shown in Fig. 3. As this arrangement results in material having to be charged and discharged at both ends of the furnace, it is sometimes more convenient to adopt a modified arrangement, working on the same principle, which may be called the return recuperative type. It is believed that whilst recuperative straight-through types have been made by a number of makers, only The Electric Furnace Company of Salem, Ohio, U.S.A., and Birmingham Electric Furnaces Limited have built the return-flow type.

An example of this type of furnace is illustrated (Fig. 4). The furnace is in use for the treatment of air-cooled engine cylinders. These cylinders are of grey cast iron with copper cooling fins cast in position, a construction causing unequal cooling and internal stresses. Warpage would occur in service unless the cylinders were aged for many months, but this is overcome by the low temperature annealing treatment, taking approximately 24 hours.

Fig. 8.—100-kw. return flow recuperative furnace for annealing brass strip in coils.



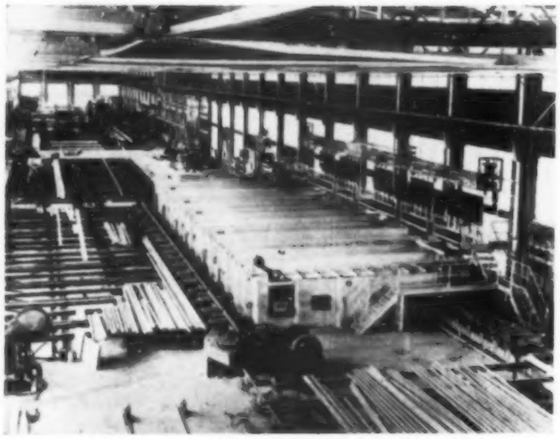


Fig. 9.—A 1,300-kw. continuous heat-treating furnace for structural shapes of aluminium alloy. Internal dimensions, 24 ft. wide × 93 ft. long.

A large number of counterflow furnaces, both of the straight line and of the return-flow type have been built for the annealing of steel in various forms, as well as for carburising, a process for which this type of furnace is excellently adapted, and for which it is probably employed to a greater extent than for annealing.

Although not recuperative, the furnace illustrated in Fig. 5 is of interest, owing to its exceptionally large size. It is a car-type furnace designed for the annealing of petroleum stills. The loading of the furnace is 3,000 kw., and it will handle stills up to 10 ft. in diameter by 65 ft. long, weighing 150 tons.. In the same way, Fig. 6 is of interest as it shows a battery of thirty-two 140-kw. double-ended furnaces, capable of annealing 200 tons of forgings per day. These furnaces are installed in a well-known automobile plant, and are used for hardening in addition to annealing. The battery is equipped with a special charging machine, this machine being used to push the forgings through the furnace into the quench tank on the opposite side, if hardening is required.

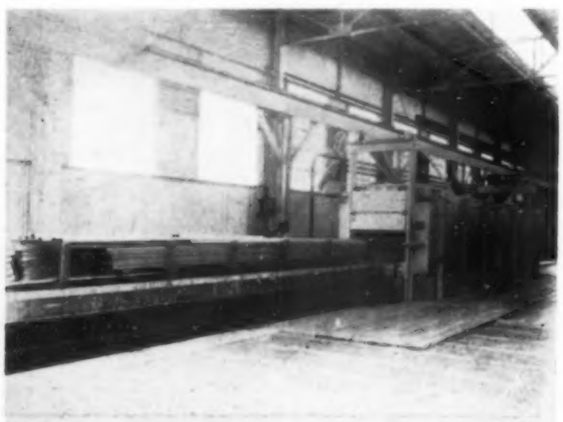
Annealing of Non-ferrous Metals.

For the annealing of metals between passes in rolling mills, batch type furnaces are usually installed, as the operations do not conveniently allow the use of recuperative furnaces of the continuous type. In a few cases, partial recuperation is obtained by means of heat exchange chambers in conjunction with batch type furnaces. However, in view of the increased economy which can be obtained from the continuous type of recuperative furnace, efforts will be made in the future to plan mills so that this type can be employed.

Continuous recuperative furnaces of the return-flow type have, however, been installed for the finish annealing of brass. Fig. 7 shows a large furnace capable of annealing two tons per hour of drawn and stamped parts, with a very low consumption of energy. This type of furnace has the further advantage of very great uniformity of temperature, and it is found possible in practice to anneal at a lower temperature than was formerly required.

Another example of a return flow brass annealing furnace is shown in Fig. 8.

Fig. 10.—200-kw. double-ended car type furnace for annealing nickel rods and tubes.



Large Scale Aluminium Heat-treatment.

A furnace built for the heat-treatment of aluminium alloy structural shapes in shown in Fig. 9. It is the largest of its kind in the world. The interior width of the chamber is approximately 24 ft. and the length 93 ft., which permits of the handling of shapes up to 90 ft. in length. The stock enters this furnace on a mechanically operated carrier, and is then carried across the furnace by a type of walking beam. The electrical rating is 1,300 kw., and the furnace is divided into 26 zones, each separately controlled by automatic temperature regulators, so that perfect uniformity of temperature is ensured under all conditions. The piece is discharged from the furnace by means of a power-operated roller table, and is automatically quenched as it leaves the furnace by means of high-pressure water sprays. The work then passes to a transfer, bringing it to the line of roller tables immediately adjacent to the furnace, and here it is straightened. After being cut to length, certain of the alloys are afterwards given a low-temperature ageing treatment in an oven 90 ft. in length. It should be added that whilst this furnace is used for annealing, most of the work is a hardening heat-treatment process and not annealing, but it seems appropriate to describe this furnace under the heat-treatment of non-ferrous metals.

A 200-kw. double-ended car-type furnace equipped with electric rack and pinion car puller, used for annealing nickel rods and tubes up to 25 ft. long, is illustrated in Fig. 10.

As already stated this part is devoted to electric furnaces used for the annealing of metals. Very many types of furnaces have been built for this work and it has only been possible for the purposes of this article to select a few of the more interesting or unusual examples. In a later article it is intended to give examples of a more general nature, bringing in the hardening and carburising of steel, where mechanical methods have been employed to a marked degree.

The Bessemer Gold Medal Award.

The Council of the Iron and Steel Institute have this year awarded the Bessemer Gold Medal to Professor Henry Louis, M.A., D.Sc., in recognition of his distinguished work in the fields of mining and metallurgical science.

Catalogues and Other Publications.

The January issue of *The Welder* contains a number of interesting and informative articles, including "Arc-welding in Shipbuilding Construction," by Dr. J. H. Paterson; "Some Recent Developments in Welding for the Chemical Industry," by J. Leverick, A.M.I., Mech.E.; "First Aid in Oxy-acetylene Welding," by W. Bennett, and on several other important subjects. Copies are available on application to Murex Welding Processes, Ltd., Ferry Lane Work, Walthamstow, E. 17.

The Sulzer Technical Review, No. 4, contains a description of the chemical and metallurigeal laboratories at the Sulzer works, which have recently been extended. Further articles deal with the Diesel electric locomotives supplied to the Royal State Railways of Siam; to special acid-resisting pumps constructed in stainless steel, and to a silicon-iron alloy, known as thermisilid. In addition, this issue gives some particulars of new Sulzer workshops for apprentices.

Aluminium Sheet Production

By Robert J. Anderson, D.Sc.

Part XI.—Planning Methods.*

Methods of planning the mill practice in producing aluminium sheet of various sizes, gauges, and grades are discussed; typical mill tickets and tables for use in calculating are shown; and typical examples of order calculations are given.

IN planning sheet production proper allowances must be made in the choice of slab size for shearing. Allowances are to be made for the rough shearing, trimming, and squaring of slabs, for the finish shearing to width and length in the case of flat sheet, and for the edge trimming of coil in slitting to width. Proper scrap allowances must, of course, also be made in planning circle production, whether such stock is cut from squares on a circle shears, or blanked from strip or coil on a punch press. Broadly speaking, shearing allowances should not be too close—either for slabbing stock or for finished material. It is better policy in planning to take a little larger scrap loss on shearing and be sure of getting the desired sizes, than to figure too closely and run the risk of shortages from lots which cannot be cut to the required dimensions.

The allowances to be made for shearing are governed by various factors, including the following: (1) The composition of the material rolled, which, in turn, determines the tendency to crack in from the edges; (2) the condition of the material, whether slabs, finished sheets, coils, or circles; and (3) the size of the sheet—gauge, width, and length. Larger allowances are made for the harder alloys as compared with 99+% aluminium, because of the greater tendency of the former to crack in and split. Also the shearing allowances are generally to be increased with increasing size (width and length) of sheet and with decreasing thickness.

In planning slab dimensions the practice in some mills is to make an average allowance of 10% for stock shearing. Slabs for flat-sheet production may be sheared before or after the slabbing operation, as will be explained in more detail in the next article of this series. The actual amount of stock-shear scrap in shearing aluminium flat-sheet slabs—*i.e.*, ends,—may vary between, say, 6 and 12%, depending on the width of the slab and its thickness. Aluminium flat-sheet slabs ordinarily do not require side shearing, but the hard alloys should be side trimmed to prevent cracking in from the edges. The amount of stock-shear scrap in shearing aluminium coil slabs—*i.e.*, sides and ends—averages about 12·5% in practice. Ordinarily, a piece about 4 in. long is sheared from each end, and a strip ½ in. wide is sheared from each side in order to remove ragged edges.

In the case of duralumin an allowance of about 10% may be made for scalping. About 15% may be removed in slab shearing, and an additional 15% in shearing after the second roughing operation.

Referring now to the allowances made for finish shearing to size, Table IV gives the end and side allowances made in one plant for flat sheet. The data indicate the effects of length, gauge, and width on the necessary allowances. In another plant the shearing allowances for flat sheet are as shown in Table V, the allowances being governed by the gauge, irrespective of length and width. In both tables the data refer to 99+% aluminium; the gauge numbers are in the Brown and Sharpe system (A.W.G.). In one plant the practice is to allow 2 in. for side shearing in the case of flat sheet up to 55 in. wide and heavier than 20 gauge, and 3 in. for over 55 in.; allowance of 4 in. is made for flat sheet up to 36 in. wide and 20 gauge or lighter (rolled in pack), and 5 in. for over 36 in. wide. The end- and side-shearing allowances are increased with decreasing thickness because of the increasing tendency of the metal to crack in the lighter gauges.

* *Continued from January issue page 90.*

TABLE IV.

SCRAP ALLOWANCES FOR FINISH SHEARING ON FLAT SHEET.

Finished Length, In.	*Allowance for End Scrap, In.					
	Heavier than 20-gauge.			20 to 25-gauge Inclusive.		26 to 34-gauge Inclusive
	Finished Width, 40 in. and Less.	Finished Width, 41 to 50 in.	Finished Width, 51 to 60 in.	Finished Width, 40 in. and Less.	Finished Width, 41 to 50 in.	Finished Width, 40 in. and Less.
74 in. and less......	10	12	16	18	20	25
75 to 100	12	14	17	20	22	26
101 to 114	13	15	18	21	23	28
115 to 124	14	16	19	22	24	30
125 to 136	15	17	20	24	26	32
137 to 144	16	18	22	26	28	34
145 to 168	18	20	24	30	32	35
*ALLOWANCE FOR SIDE SCRAP, INS.						
All lengths	2	2	2	3 to 4	4	4

* The allowances in inches refer to both sides and both ends. For example, in the case of 18-gauge sheet to finish 50 in. by 100 in., 7 in. is sheared off each end and 1 in. off each side.

TABLE V.

SCRAP ALLOWANCES FOR FINISH SHEARING ON FLAT SHEET.

Finished Gauge.	*Allowance for Side Shearing, In.	*Allowance for End Shearing, In.
7 and heavier...........	2	6 to 7
8 to 10 inclusive	2	8 to 10
11 to 13 inclusive	2	11 to 13
14 to 18 inclusive	2	14 to 18
19 to 20 inclusive	4	18 to 20
21 to 23 inclusive	5	20 to 22
24 to 26 inclusive	6	20 to 22
27 to 30 inclusive	7	22 to 24

* The allowances in inches refer to both sides and both ends.

The allowance for side scrap in trimming coil to width on a slitter is usually about ½ in. to ⅝ in., on each side, for aluminium. No allowance is made for end scrap, but a short piece is ordinarily cut off each end at the slitter. Short pieces may also be cut off at the various coil mills. In squaring coil or flat sheet for circles an allowance of ½ in. all around is sufficient for the circle-shearing operation. This may be increased somewhat for large circles. When circles are made by blanking coil or strip on a punch press, the overall width may be run ¾ in. to 1 in. wider than the diameter of the circle. The allowance to be made for loss between circles may be ¾ in. to 1¼ in. With automatic feed on the punch press, this depends upon how closely the setting may be made and maintained.

The Slab Cuts.

In the case of flat-sheet production, only one, several, or a larger number of sheet, say up to 10, may be obtained from an ingot. The number necessarily depends on the size of the finished sheets in relation to the size of the

ingot from which rolled. In practice, depending on circumstances, slabs may be cut to length before or after the slabbing operation—usually the latter,—but in either case the correct length of cut must be determined. For a given thickness, irrespective of width, the length of the cut must be such that the piece will " roll out " to the required finished length (plus end scrap allowance) at the finished gauge. The width is provided for in the original width of the hot-rolled slab. If the slab pieces are to be cross-rolled, proper provision is made in the planning.

Coil slabs may, of course, be split longitudinally into two or three pieces before the roughing operation, but it is more usual to roll narrow coil in multiple widths and slit to size on trimming after finishing to gauge.

The method of determining the length of pieces to be sheared from slabs for flat-sheet rolling, and hence the possible number of cuts per slab, may be explained as follows:—

The quotient of the division—

$$\frac{\text{Slab thickness}}{\text{Finished-gauge thickness}} = \text{a factor.}$$

This factor states the number of times the slab piece is lengthened in rolling to gauge. As an example, if the thickness of the slabbed slab is 0·125 in., and the finished thickness is to be 20 gauge (0·032 in.), then the piece will be elongated approximately four times in the roughing and finish rolling.

Knowing the required finished length and the scrap allowance for end shearing, the necessary length of cut to be made on the slab is the quotient of the division—

$$\frac{\text{Finished length} + \text{scrap allowance}}{\text{A factor}}.$$

Then the number of cuts per slab is the quotient of the division—

$$\frac{\text{Length of slab}}{\text{Length of cut}}.$$

Hot-mill slabs may be cold slabbed to nominal thicknesses, such as 0·1 in., 0·125 in., 0·15 in., and 0·2 in., before roughing. For planning purposes, it is convenient to have tables drawn up indicating the usable lengths of slabs, at these thicknesses, corresponding to various widths over the usual range produced. Similar tables may also be prepared as applying to the common thicknesses (0·25 in., 0·375 in., 0·4 in., etc.) and widths of the hot-mill slabs. Tables may also be drawn up giving the factors corresponding to reductions from the several nominal slab and slabbed thicknesses to the numerous finished-gauge thicknesses.

The usable length of slab is necessarily less than the indicated length, for a given thickness and width, obtained by calculation. This follows because the ends are rounded or distorted out of square, and may be split in from the edges. Any allowance made for side shearing must be accounted for also, as affecting the overall dimensions.

Recovery in Processing.

An accumulation of data, based on first-hand experience, regarding the recovery of acceptable sheet per ingot, or rather per unit weight of ingots, is invaluable for the work of planning. The recoveries obtained in producing aluminium and aluminium-alloy sheet and coil are necessarily governed by numerous factors of which the following are important: (1) The composition of the material (whether aluminium or an alloy); (2) the size of the sheets (area and gauge); (3) the size of the ingots used in relation to the size of the finished sheets; (4) shearing losses; (5) operating scrap arising in the processing, other than from shearing; and (6) quantities of metal rejected on inspection. In the foregoing discussion the effects of most of these factors have been indicated.

Disregarding production costs, the criterion of satisfactory mill operation—and, of course, planning—is the recovery of acceptable material as referred to the poundage of ingots hot rolled. Obviously the working time of a plant cannot be devoted for the most part to making scrap. Recovery can determine whether a mill operates profitably.

From the point of view of planning alone, recovery may be considered as the amount of material delivered to the inspection bench as referred to a unit weight of ingots. The planning department cannot be held responsible for losses arising on inspection which are due to defects in the original ingots, poor mill practice, careless handling, and to other causes. Actual recovery, as referred to the poundage of ingots hot rolled, must be based on the corresponding poundage which passes inspection. If allowances are to be made in the planning for probable losses on inspection, past experience is the best guide.

Broadly stated, the order of recovery obtained in processing aluminium-sheet products may be taken as follows:—Highest—(1) coil: (2) flattened coil: (3) grey plate: (4) bright flat sheet: (5) coil circles; and least—(6) flat-sheet circles. Thus, recoveries may range from, say, 40% of the ingot weight for circles to 80% for coil. This refers to aluminium. The corresponding recoveries for heat-treatable alloys are normally lower.

It is to be understood that various factors other than the class or grade of sheet rolled affect the recoveries—*e.g.*, temper. Thus, take the case of bright flat sheet; this is troublesome material to make in the dead-soft temper because of its tendency to blister on annealing. Blisters spoil the surface appearance and cause rejection of otherwise good material. Hence, the recovery of bright flat sheet when made as 2SO may be low. On the other hand, considerably higher recoveries are normally obtained with the same material when made in the full-hard temper (2SH). Somewhat higher recoveries may be had with any class of sheet when made in an intermediate temper as compared with the dead-soft temper. This follows because slight blisters, formed on annealing, which might cause rejection are rolled in or " ironed out " on rolling to temper (after annealing) and are hence not noticeable. As a general rule annealing at any stage of the processing tends to increase losses.

The skeleton loss in producing circle stock, either by circle shearing or blanking, is necessarily a function of the diameter. Thus, if a uniform allowance of ½ in. all around is made for the shearing—*i.e.*, the side of the square is 1 in. greater than the diameter of the circle, the loss increases with decreasing diameter. As an example, the skeleton loss in making 16-in. diameter circles from 17-in. squares is about 31·5%: the corresponding loss in making 4-in. diameter circles from 5-in. squares is about 49·7%.

At one plant the average recovery over a period of time was about 60%, this being the ratio of pounds of sheet shipped (passed by the inspector) to the pounds of ingots hot rolled. The material produced included circles, coil, flattened coil, grey plate, and bright flat sheet in a wide range of sizes and gauges; both 2S and 3S were represented. The indicated average recoveries for the several items were as follows: Coil circles, 52%; coil (and flattened coil), 68%; grey plate, 61%; and bright flat sheet, 57%.

At one plant the average recovery for duralumin sheet and coil, covering the usual commercial sizes, gauges, and tempers, is about 35%.

Table 6 gives a record of the process and inspection scrap arising in the production of a small lot of 14-in. diameter coil circles, 19-gauge, 2SO. A total of 15 ingots, averaging about 103 lb. each, weighing 1,547 lb., was rolled for the lot. Total scrap loss in the mill was about 42%, and 58% passed inspection.

Examples of Order Calculations.

Some typical examples of order calculations are given herewith to illustrate the methods of planning production. Aluminium-sheet orders are usually specified by consumers in one of two ways, viz., (1) a certain number of sheets (coils or circles) of specific size, gauge, temper, and composition; or (2) a certain number of pounds of given material.

Example No. 1:—An order such as the following may be received by the mill: 25,000 lb., 12-gauge, grey plate,

12 in. by 90 in., 2SO. Calculation is to be made for the number of ingots to be rolled and the length of cut on the slabs.

It will be assumed that the standard size ingot used in the plant measures $3\frac{1}{4}$ in. by 14 in. by 24 in., weighing 101 lb.

No. 12-gauge is 0·0808-in. thick, and weighs approximately 1·13 lb. per sq. ft.

The side shearing allowance for the finish is 2 in., and the end allowance 12 in.

The ingots will be rolled to slabs of double width, and the slabs split longitudinally. Hence, the slab width will be 28 in. In the preliminary rolling the ingots may be broken to slabs $\frac{3}{8}$ in. thick, these being subsequently cold slabbed to $\frac{1}{8}$ in. thick (0·125 in.).

$$\frac{0\cdot125}{0\cdot0808} = 1\cdot55 \text{ (the thickness factor).}$$

Allowing for end scrap, the finished length of the sheets will be $90 + 12 = 102$ in.

$$\frac{102}{1\cdot55} = 66 \text{ in., the length of cut on the slabs.}$$

TABLE VI.

RECORD OF RECOVERY AND LOSSES IN PRODUCTION OF A LOT OF CIRCLES.*

Item.	Lb.	%.
Rolled 15 ingots	1,547	100
Stock-shear scrap: Ends	102	6·6
Stock-shear scrap: Sides	94	6·5
Scrap in coil rolling	23	1·7
Scrap in squaring	20	1·5
Scrap in circling	370	28·3
Total process scrap	609	39·4
INSPECTION RESULTS.		
Slivers	13	1·4
Rolled-in scratches	7	0·7
Holes and pits	15	1·6
Emboss marks	1	0·1
Dirt	6	0·6
Total inspection scrap	42	4·5
Total scrap loss	651	42·1
Total passed inspection	896	57·9

* 2SO, 19-gauge, 14 in. diameter, coil circles.

The usable length of a slabbed slab $\frac{1}{8}$ in. thick and 28 in. wide, as rolled from a $3\frac{1}{4}$ in. by 14 in. by 24 in. ingot, after end shearing, will be about 277 in. Then the number of cuts per split slab will be—

$$\frac{277}{66} = 4 \text{ (+ 13 in. average).}$$

There are four cuts per split length and two cuts per total width, or a total of eight pieces per ingot.

$12 \times 90 = 1{,}080$ in. per finished sheet.

$1{,}080 \times 8 = 8{,}640$ in. of finished sheet per ingot, which is equivalent to 60 sq. ft.

$60 \times 1\cdot13 = 67.8$ lb. of finished sheet per ingot.

This is equivalent to a recovery of approximately 67·1%, no allowance being made for inspection losses.

If an allowance of 10% of the total order is applied for process (other than shearing) and inspection scrap, then

$25{,}000 + 2{,}500 = 27{,}500$ lb. of ingots should be hot rolled.

$$\frac{27{,}500}{67\cdot8} \times 406 \text{ ingots to be rolled.}$$

Example No. 2 :—This is an order for 400 lb., 19-gauge, bright flat sheet circles, $12\frac{3}{4}$ in. in diameter, 2SO.

It will be assumed that the material is to be rolled from ingots measuring $4\frac{3}{4}$ in. by 12 in. by 20 in., weighing about 106 lb.

No. 19-gauge is 0·0359 in. thick, and weighs about 0·5 lb. per sq. ft.

There is no side stock shearing done on flat-sheet slabs for material to finish heavier than 20-gauge.

If the circle shearing allowance is taken as $\frac{3}{8}$ in. all around, then the squares must measure $13\frac{1}{2}$ in. on a side.

The ingots will be rolled to slabs of double width, and the slabs split longitudinally ; the slab width, accordingly, will be 27 in. The thickness of the slabbed slabs is 0·125 in.

The required finish length of the sheet ready for shearing into squares is figured as 81 in.—*i.e.*, six cuts $13\frac{1}{2}$ in. long. Allowing 6 in. for end scrap, which is sufficient for trimming, the total length may be taken as 87 in.

$$\frac{0\cdot125}{0\cdot0359} = 3\cdot48 \text{ (the thickness factor).}$$

$$\frac{87}{3\cdot48} = 25 \text{ in., the length of cut on the slabs.}$$

The usable length of a slab cold slabbed to $\frac{1}{8}$ in. thick and 28 in. wide, as rolled from a $4\frac{3}{4}$ in. by 12 in. by 20 in. ingot, after end shearing, will be about 302 in. Then the number of cuts per split slab will be—

$$\frac{302}{25} = 12 \text{ (+ 2 in. average).}$$

There are 12 cuts per split length, two cuts per width, and six squares per piece. This amounts to 144 squares or circles per ingot.

An aluminium circle, 19-gauge, $12\frac{3}{4}$ in. diameter, weighs about 0·448 lb. Since 144 circles can be obtained per ingot, then the planned weight is

$$0\cdot448 \times 144 = 64\cdot5 \text{ lb.}$$

If an allowance of 10% of the total order is applied for process and inspection scrap, then

$64\cdot5 \times 0\cdot9 = 58$ lb. (probable minimum recovery).

$$\frac{400}{58} = 7 \text{ ingots to be rolled.}$$

Example No. 3 :—This is an order for 30 sheets, 18-gauge, grey plate, 48 in. by 144 in., 2S8.

The material is to be rolled from ingots measuring $3\frac{1}{4}$ in. by 14 in. by 24 in.

No. 18-gauge is 0·0403 in. thick, and weighs about 0·561 lb. per sq. ft.

The side shearing allowance for the finish is 2 in., and the end allowance is taken as 16 in.

In the processing, the material may be slabbed to $\frac{1}{8}$ in., roughed to 10-gauge, annealed, and finish rolled to 18-gauge.

$$\frac{0\cdot125}{0.0403} = 3\cdot1 \text{ (the thickness factor).}$$

The finished length of the sheets is $144 + 16 = 160$ in.

$$\frac{160}{3\cdot1} = 52 \text{ in., the length of cut on the slabs.}$$

The usuable length of a slabbed slab $\frac{3}{8}$ in. thick and 50 in. wide, as rolled from an ingot of the size given, after end shearing, is about 155 in. Then the number of cuts per slab will be

$$\frac{155}{52} = 3.$$

If an allowance of 10% of the total order is applied for process and inspection scrap (other than shearing losses), then

$$30 + 3 \times 33 \text{ pieces.}$$

$$\frac{33}{3} = 11 \text{ ingots to be rolled.}$$

As indicating the relation of ingot size and finished-sheet size on shearing losses—*i.e.*, slab ends left on cutting to length, the following may be noted :—

If the above order were rolled from ingots measuring 4 in. by 12 in. by 20 in., the usable length of slab ($\frac{1}{8}$ in. thick and 50 in. wide), after end shearing, would be about 137 in. Then the number of cuts per slab would be

$$\frac{137}{52} = 2 \text{ (+ a slab end of 31 in.).}$$

The above simple examples serve to give an idea of the methods employed in calculating requirements for specific orders. It will be clear that heavy slab-end losses may be taken in rolling specific sizes of sheet if the correct size of ingot is not chosen. At the same time it is more advisable to take such losses on a few orders, using one standard size ingot, and avoid the necessity of having many sizes or ingot moulds in the plant.

Reviews of Current Publications.

A Treatise on Photo-Elasticity.

It is gradually being forced upon the designer and engineer that the ordinary methods of testing materials are not sufficient to give full and reliable theoretical data for application to the design of various structures. These methods do not nowadays suffice for the varied needs of modern engineering practice, and it has become necessary to investigate the properties of material under stress by many other methods of a more elaborate kind. These are proving very useful in guiding engineers in their designs, but it is difficult to interpret and co-ordinate them in a satisfactory manner. The authors of this work appreciate this fact, and suggest that there is ample field for inquiry concerning the scientific basis of practically all the modern developments of tests of materials, as these almost invariably give complex stress distributions, as, for example, near the boundaries of the contact areas in various forms of hardness testing, and at notches employed in impact test specimens. These and other questions, like the stress effects of repeated loading, the changes in microscopic and atomic structure produced by the application of loads, as well as many others, form the principal features of modern inquiry.

It is with the object of providing applicable mathematical and physical data that photo-elastic science is being developed, and this valuable work on the subject not only provides the essential data which the authors found necessary in their investigations, but also a connected account of the principal technical developments. Originally intended to explain some of the essential features of photo-elastic science by elementary methods, the authors were compelled to depart from their primary object, in view of the complexity of the subject, in order to cover the field adequately, with the result that the work is large and comprehensive, and in its present form provides a very valuable treatise on photo-elasticity.

In a complex subject such as this, which involves a sound knowledge of optics, as well as the elastic behaviour of materials, each section embraced by photo-elasticity must be considered separately in order that the technical developments can be connected. Thus, in this work, the principal facts associated with optics in relation to photo-elasticity are given in the first chapter. In their theoretical aspect they have been developed in accordance with the electromagnetic theory of light, which provides the most direct and simple method of accounting for the phenomena of propagation of light in crystals and of interference. Another fundamental subject which is given early consideration is the elastic behaviour of materials. This is discussed in Chapter II., but only within the scope of two-dimensioned stress and strain with which photo-elasticity at present deals. A very complete historical summary of the early discoveries and subsequent developments of photo-elasticity, considered as a branch of physics, is given in Chapter III. This deals with research work appertaining to the subject from the time of Brewster to the present day.

The further sections deal with a number of problems of scientific and practical engineering interest, in which photo-elasticity has been found useful in advancing knowledge of plane stress distribution, due to applied loads, and also, to a limited extent, imposed determinate strains. Thus, in Chapter IV. a number of problems are discussed concerning plane strain and plane stress, involving straight and circular boundaries. These include thick cylinders with concentric and eccentric outer boundaries, circular rings under flexure, and the distribution due to force applied at the apex of a wedge, which may be taken as fundamental in the consideration of the action of cutting tools. Stress distributions resulting from bending and tapering members, from contact pressure, and from isolated forces and couples in an infinite plane, are also discussed. The chief researches on plane stress in the flexure of straight and curved beams are given in Chapter V., while Chapter VI. deals with the application of mathematical and photo-elastic research to stress distributions from circular and other forms of holes in members to be fabricated. The importance of testing materials on a scientific basis is stressed, and in torsion-test specimens the shape of the ends in various standards are examined in Chapter VII., which also includes effects on the distribution of stress due to methods of gripping a cylindrical test bar.

It is appreciated that many of the problems discussed may occur in structures and machines in combinations of great complexity, and the authors have set apart the concluding chapter on the application of photo-elastic methods to the solution of these difficult problems. The scope of this section is very considerable, and shows the possibilities of further investigation in this field.

The value of this branch of science to the designer and engineer cannot be over-estimated. It provides the means for an immediate practical solution of fundamental problems concerning the stresses in the elements of structures and machines, which cannot be otherwise directly observed, and which are usually beyond the reach of calculation. In the solution of technical problems only the fringe of the possibilities of photo-elasticity has been applied: with increasing knowledge of the subject, however, and the development of technique in its application, it will become a recognised and valuable aid to the engineer. This work not only provides a basis for the solution of problems within the range of photo-elasticity, but will prove an incentive to further development.

The treatise is exceedingly well illustrated, a considerable number of the illustrations being in colours, which indicate so clearly the distribution of stresses when a member is under load. The method of numbering the articles, formulæ, and illustrations is noteworthy. The decimal system of notation has been adopted throughout. In addition to subject and name indexes, a very useful bibliography is appended giving an almost complete index of works on photo-elasticity.

By E. G. Coker, M.A., D.Sc., F.R.S., and L. N. G. Filon, M.A., D.Sc., F.R.S. Published by the Cambridge University Press, Fetter Lane, London. Price 50s. net.

Symposium on Malleable-Iron Castings.

The symposium in which the papers and data published in this book were given was held in a session of the 1931 A.S.T.M. annual meeting, and was sponsored jointly by the American Foundrymen's Association and the American Society for Testing Materials. The committee which prepared the book has reviewed critical data on malleable iron from a large number of diversified sources, and compiled a complete and authoritative summary of the known chemical, physical, mechanical, and electrical properties of malleable iron.

The symposium gives available data on properties of malleable iron, much of which has not previously been gathered in a concise form. There are sections given over to supplementary data and discussions of tensile properties. A statistical analysis of the tensile test data, prepared by Dr. W. A. Shewhart, of the Bell Telephone Laboratories: whilst other sections are devoted to higher strength malleable iron, cupola malleable iron, and the necessity of co-operation between engineer-designer and the foundry. A résumé of current specifications for malleable-iron castings is also given, an extensive paper by O. W. Boston, Professor, College of Engineering, University of Michigan, dealing with "An Investigation of Metals to Determine the Machinability of Malleable-Iron Castings," as also is a paper on "Corrosion of Malleable Iron," by Messrs. F. L. Wolf and L. A. Meisse.

Copies of this book can be obtained from the American Foundrymen's Association, 222 W. Adams Street, Chicago, or the American Society for Testing Materials, 1315 Spruce Street, Philadelphia. The price is 75 cents with heavy paper binding.

Hollow Forged Vessels for High Temperatures and Pressures

By Capt. Ronald Benson, M.C., B.Eng.*

In addition to large quantities of forged drums for high pressure boilers, produced at the Sheffield Works of The English Steel Corporation, hollow forged pressure vessels of various sizes and types, for use both in this country and overseas, are also manufactured in large numbers, the production of which is discussed in this article.

EACH succeeding year sees an increasing demand for large hollow forged steel pressure vessels for use in chemical and oil engineering processes. The large size of the forgings required is sufficient in itself to make the production of such vessels a matter of note from the engineering point of view, whilst the very complex investigations necessary to determine correct methods of design and the most suitable materials are of the utmost interest to all metallurgists and designers.

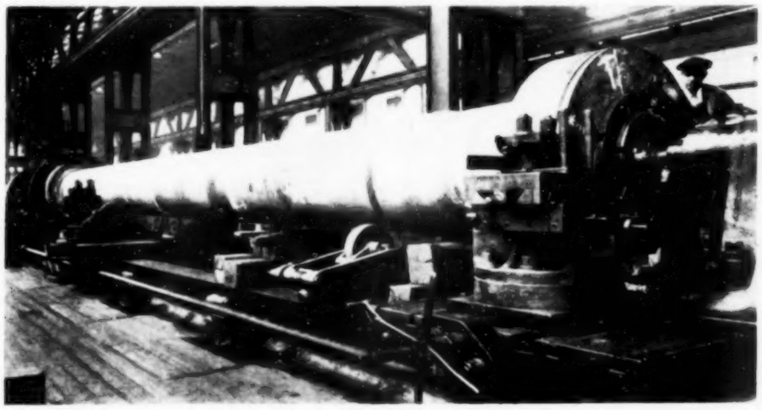


Fig. 1.—Machining a forging for a pressure vessel having separate covers.

It is not intended in this article to discuss the reasons for adopting the various shapes and types of vessel, but merely to indicate what demands have been made upon the steel-maker, and how these have been met.

The forms adopted by the designers of pressure vessels vary very greatly, some vessels being designed with great length and comparatively small diameter, whilst in other cases, where a larger diameter is called for, the length is correspondingly reduced; in many cases the dimensions of the finished vessels are governed by considerations of maximum weight of the hollow forgings which the steel-maker is able to produce.

The methods adopted for closing the ends of pressure vessels are: (*a*) By means of separate covers attached to the ends; (*b*) by closing or "bottling" one end of the hollow forging in a manner similar to that used in making high-pressure boiler drums; (*c*) by "bottling" both ends of the forging.

When the ends of the vessels are closed by covers, it is usual to secure these covers to flanges on the ends of the forging by bolts. Fig. 1 shows the machining of a forging of the first type; its length is 50 ft., and flanges are formed at the ends, to which covers can be bolted. A vessel of the second type is shown in Fig. 2, one end of which is closed by "bottling," the other end having a cover secured to it. The internal diameter of this tube is 53 in. In Fig. 3 a vessel of the third type is illustrated, both ends of which have been "bottled" under a forging press.

An alternative method of securing covers to the tubes is known as the "Vickers-Anderson Joint"; this joint was used to connect the various portions of the large high-pressure wind-tunnel recently installed in the National Physical Laboratories at Teddington. It can also be used to connect the tubular portions of a pressure vessel when it is made in two or more parts.

In general, the requirements of designers of forged vessels have necessitated the production of tubes of diameters between 3 ft. and 5 ft., and of lengths up to 50 ft. The weight of material needed to make such tubes is comparatively large. Ingots weighing as much as 170 tons have been used, and even larger ingots are projected.

Fig. 4 shows an ingot weighing 165 tons, used for such work. It is not possible to produce such an ingot from one furnace, and exact control of the melting process is needed to obtain uniformity when several furnaces are tapped into one mould. It is advisable, in order to ascertain that reasonable homogeneity and correct composition of material have been obtained, to take drillings from such ingots after the discard has been removed; these drillings are taken in various positions from the

Fig. 2.—Hollow forging with one end "bottled."

* Forge Manager, English Steel Corporation, Vickers Works, Sheffield.

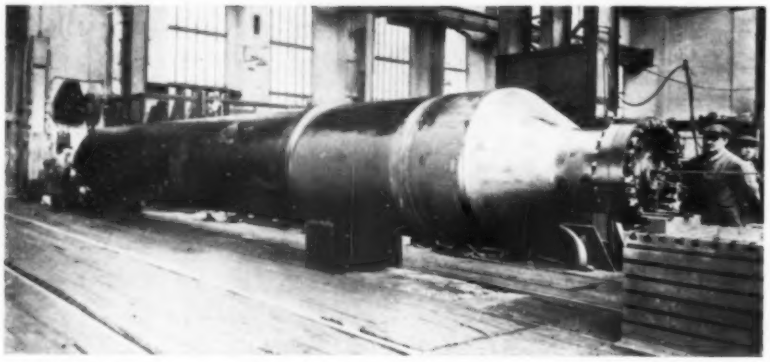


Fig. 3.—Forging with both ends bottled by swaging operations.

centre to the outside at each end, so that variations of chemical analysis may be checked. A billet weighing 104 tons, which has been examined in this way, is shown in Fig. 5; the points at which drillings have been taken are visible at one end.

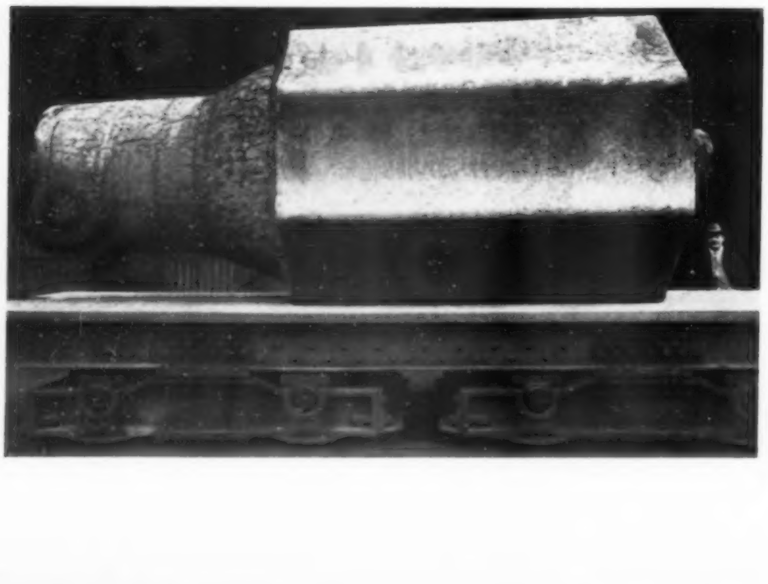
In addition to cranes and hydraulic presses of sufficient size and power, a considerable amount of experience and technique is needed to enable such ingots to be re-heated and forged successfully. This will be appreciated on reference to Fig. 6, which shows a partly made forging, for a large pressure vessel, under an 8,000-ton press in the works of the English Steel Corporation. A comparison with the man beside the forging will indicate the size of plant needed for such work.

In producing hollow forgings, the practice of most makers is to anneal the ingot after stripping it from the mould (whilst still hot), afterwards cooling it slowly in the furnace. The object of this cooling of the material is to allow a hole to be made through the centre of the ingot by trepanning, so that a hollow forging can be produced. As alternatives, cooling is sometimes carried out very slowly in a soaking pit, and in some cases the ingot is forged or "cogged" in the solid state into a round or octagonal bloom before annealing or cooling, a sufficient reduction in size being made to break up the crystalline structure resulting from casting.

The cooling of a large alloy steel ingot or bloom whose weight is of the order of 100 tons may occupy a period of three or even four weeks; in order to save this time, and also to obviate the possibility of stresses caused by cooling, the English Steel Corporation has developed a process of "hot piercing," or punching, whereby a hole is made through the ingot without cooling it.

In this process the feeder head at the top and the surplus metal at the bottom of the ingot are cut off by means of a large cutter or "knife," which is driven through the ingot by a hydraulic press. The remaining body of the ingot is next placed under a press so that its axis is vertical, and a tubular punch is driven axially through the ingot. By this means a central core is removed which contains the less pure material from the axis of the ingot, and a hollow billet is thus prepared from which the forging is made by the usual processes of expanding (where necessary), drawing on mandrels (except for such short forgings as can be produced by expanding only), and (where required) "bottling" or closing the ends.

Fig. 4.—Ingot weighing 165 tons, cast for the production of a forged vessel.



It will be realised that when the "hot piercing" process is employed the completed forging is made from metal which has never been allowed to cool below a red heat, after casting, until it has been annealed as a finished forging. Fig. 7 shows a subsequent "roughing" forging operation on a billet made in this way by piercing a hole 28 in. in diameter through an ingot weighing 91 tons.

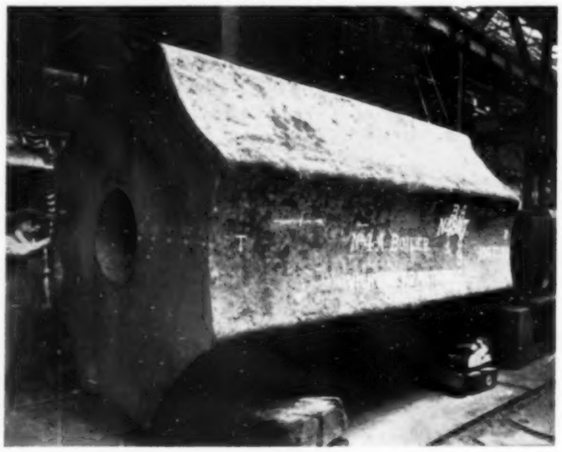


Fig. 5.—Billet weighing 104 tons from which drillings have been taken to check the chemical analysis of the steel.

The alternative method (already referred to) of cooling the ingot or "cogged" bloom, and removing the centre by trepanning, has been adopted with success where the time factor is of less importance. It has the advantage that when the surplus material has been cut from the ends of the cooled billet or ingot in a parting machine, and the hole has been trepanned through it, a thorough examination of the end faces and the bore can be carried out, the check drilling already mentioned being also carried out at this stage of manufacture.

Reference should now be made to the closing in or "bottling" of the ends. This process may be carried out at the conclusion of the forging operation if one end only is closed, the machining of the interior being then performed through the large or open end. If a forging "bottled" at both ends is required it is usual to defer the closing operation; a tube with open ends is therefore first produced, as the interior of such a tube is more readily bored. The exterior is also partly machined at this stage, and a predetermined

excess of material is left at the ends from which the closure can be produced.

The method of closing adopted for the larger pressure vessels is known as "swaging," and is somewhat similar to that used for high-pressure boilers. The end of the open-ended tube is placed between "swages"—*i.e.*, curved tools,—as shown in Fig. 8,—under a hydraulic press. The tools are then pressed slightly together so as to thicken the walls of the tube at "A" and "B." The portion of the tube which is being worked is thus reduced to a section which is roughly elliptical; the major axis is slightly greater than the original diameter owing to what is known as "bellying" or "bulging," and the minor axis is reduced by the amount which the press head has travelled. The tube is then rotated and the pressing action repeated as rapidly as possible. In this way the diameter of the forging is ultimately reduced to the dimensions required, whilst the wall is thickened in the process. From this thickened wall a flange is sometimes machined to which the cover is attached by bolts.

A pressure vessel which has been closed at the ends in this way is shown in Fig. 9; the smaller vessel attached

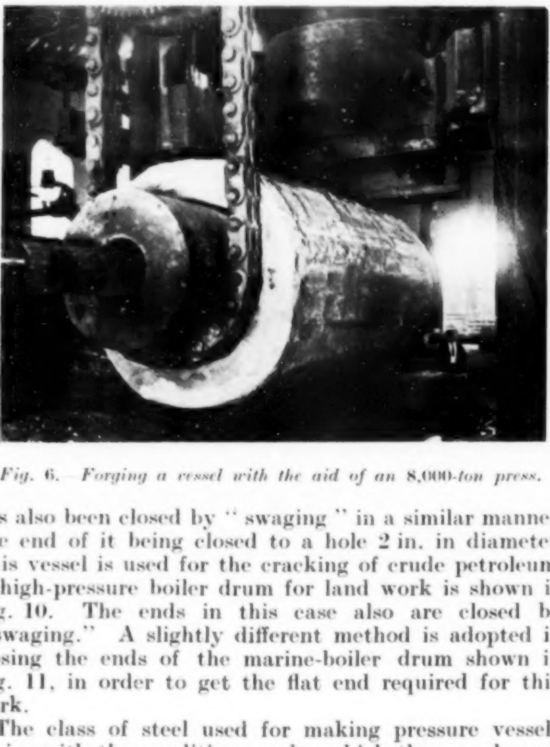


Fig. 6.—Forging a vessel with the aid of an 8,000-ton press.

has also been closed by "swaging" in a similar manner, one end of it being closed to a hole 2 in. in diameter. This vessel is used for the cracking of crude petroleum. A high-pressure boiler drum for land work is shown in Fig. 10. The ends in this case also are closed by "swaging." A slightly different method is adopted in closing the ends of the marine-boiler drum shown in Fig. 11, in order to get the flat end required for this work.

The class of steel used for making pressure vessels varies with the conditions under which the vessels are to be employed. In the cracking of crude petroleum, the high pressure involved is not associated with the very great rise in temperature which occurs in some of the chemical processes for which pressure vessels are needed; in this case a straight carbon steel of high quality, made in the acid open-hearth furnace, is found to be adequate. The grade usually employed has an ultimate stress of from 28 tons to 32 tons per sq. in.

In other processes, however, the conditions are more severe, and a steel is needed with a very low rate of "creep" at high temperatures under the stress loading set up by the working pressures involved. In addition, the steel used must resist the corroding effect of various

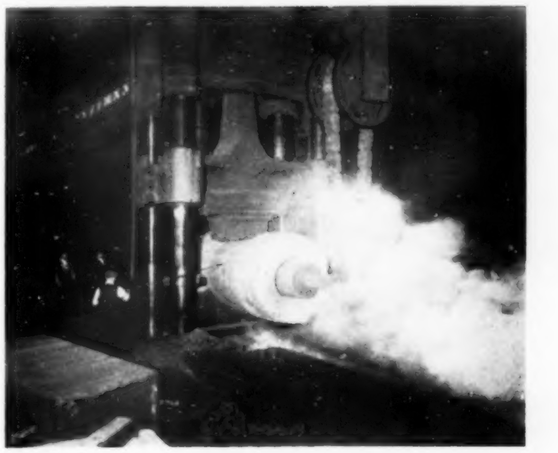


Fig. 7.—Rough-forging a billet after piercing a hole 28 in. dia.

agents, and must not be susceptible to gaseous attack, resulting in intercrystalline weakness and embrittlement, nor should it be liable to deterioration under repeated heating and cooling or under prolonged heating. Various special alloy steels fulfilling these requirements are employed, therefore, for pressure vessels working under such conditions.

Experimental work on these steels is continually in progress in the metallurgical and research laboratories

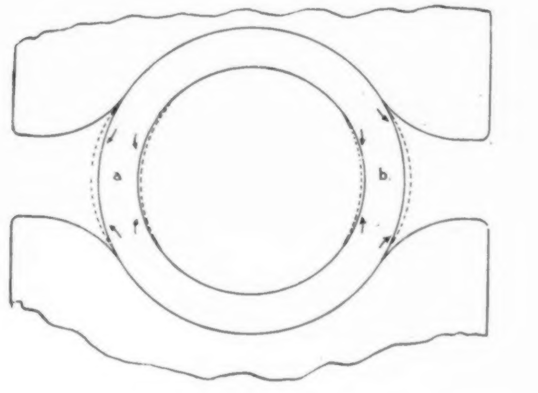
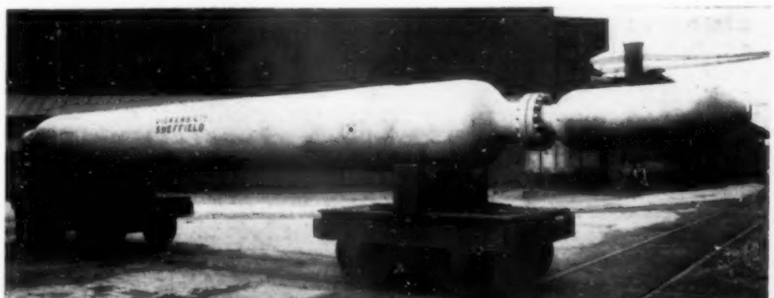


Fig. 8.—Illustrating flow of metal during swaging.

of the English Steel Corporation. For the investigation of "creep-resisting" properties, in particular, prolonged investigations involving the use of apparatus of great

Fig. 9.—Pressure vessels used for cracking crude petroleum.



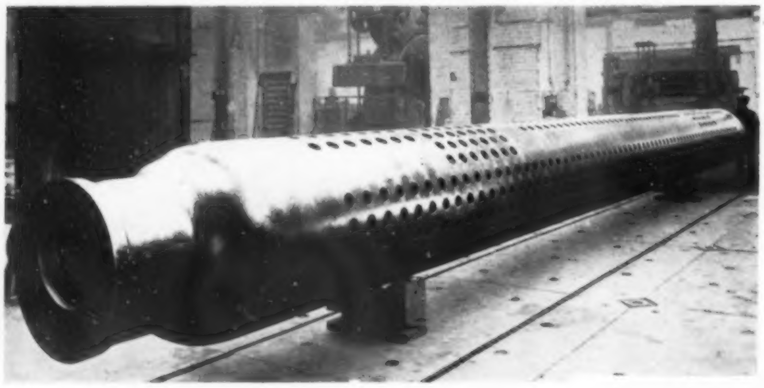


Fig. 10.—A high-pressure boiler drum for land work.

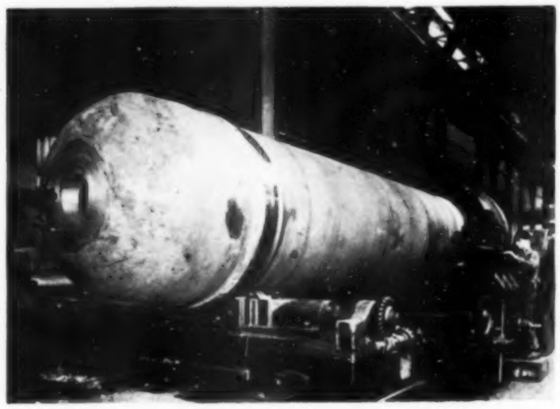
sensitiveness and accuracy are needed, and a special laboratory has been established which is devoted entirely to this work, and special "creep-testing" machines are installed in it.

Steels containing molybdenum in particular have been found to have greatly improved "creep-resisting" properties, especially where the working temperature lies between 400° C. and 500° C., and several special steels of this type are now available.

The best physical properties of all the alloy steels used for pressure vessels are obtained when the steel is employed in the hardened condition. The operation of oil-hardening forgings of the largest sizes calls for plant and experience which few firms possess; the English Steel Corporation has, however, ample resources for this work, and has been able to oil-harden successfully the largest vessels which have been produced.

The writer wishes to express his thanks to the English Steel Corporation for permission to publish this article, and to members of the staff who have assisted in its preparation.

Fig. 11.—Marine boiler drum.



Principles of Welding

Briefly outlined from the earliest known forms of welding to modern practice in the art.

THE principles of welding were outlined by Mr. J. S. Glen Primrose, C.I.Mech.Eng., at the annual lecture of the Graduates' Section of the North-western Branch of the Institution of Mechanical Engineers, delivered recently in Manchester. Perhaps the earliest-known form of welding, he stated, was the joining of the parts of soft pure iron by means of the smith's weld, which, in the past, generally resulted in the production of an area of over-heated metal. The use of simple fluxes enabled the iron parts to become intercrystallised by the use of a sufficiently low temperature to preclude overheating, and only a minimum of work was needed to effect a perfect weld. An interesting instance of the impracticability of making a successful weld in steel which had been primarily overheated was cited, and the comparative ease with which the job was done when the structure had been refined by a simple normalising heat-treatment, was explained with reference to this proper arrangement.

Another simple form of joining often used in the case of cast iron when a missing portion was "burnt" on. The flow of molten metal over the affected part raised the metal to the fusion point, and, on stopping the flow of molten metal in the prepared mould, the added portion was securely attached by intercrystallisation to the parent body and constituted a weld. Another form of fusion welding was described as the oxy-acetylene torch, in which it was possible to effect either autogenous welding, using the metal of the separate parts to fill in the veed gap between them, or, in the cases where this was too wide, a suitable filling wire to supply the needed weld metal. A very specialised technique was necessary to operate this method successfully in order to avoid the ever-present possibility of locally overheating the parent metal, and thus engendering a brittle range in it at some little distance apart from the weld, as well as an accicular structure in the weld metal itself.

The earliest form of electric welding was to employ the carbon arc, and after a period of disfavour this is returning for certain specialised work. The chief drawback to the original carbon arc weld was that no attempt was made to screen the metal passing through the arc; and thus both oxides and nitrides were often present in the added metal, with detrimental results. The use of bare wire for welding was not considered desirable for the best work, and generally a very pure steel was necessary; freedom from included slag, and even occluded gas was deemed most desirable to save spluttering of the arc and avoid unsoundness in the weld.

The possibilities of using welding rods of alloy steels for joining similar material, and also of using non-ferrous metal wires for such work were briefly discussed. The adoption of welding in quite large structures was pointed out. The fact that such severely stressed parts as locomotive engine frames had been successfully welded, while moderately sized vessels to withstand wave stresses had been constructed with satisfaction, proved the trend of modern developments, some of which even included automatic welding at much higher speeds than was possible with manual operation.

Recent Advances in Non-ferrous Metallurgy

The concluding article of a survey of the metallurgical literature of the last twelve months. The writer refers to the most outstanding features of the period under review, and indicates the trends of advance which have revealed themselves most distinctly.

Testing Methods.

Spectrographic Analysis of Metals.—The application of the spectrograph to metallurgical analysis has been carried much further than is generally realised. The spectrographic method (in which analyses are carried out by correlation of spectra) has already been applied to the analysis of copper, zinc, tin, lead, aluminium, steels, etc., especially with respect to small quantities of foreign elements. Both here and in Germany a large amount of work is being done in the systematic extension of this method to as many metals as possible, and a literature of very respectable size has already grown up round the subject. Reference may be made to two typical papers, read at the recent Institute of Metals meeting at Zurich : "Application of the Spectrograph to the Analysis of Non-Ferrous Metals and Alloys," by H. W. Brownsdon and E. H. S. van Someren,[19] and "Spectrographic Analysis of Some Alloys of Lead," by D. M. Smith.[20] Where applicable, the spectrographic method has many advantages, especially as regards speed, and there can be no doubt that it will sooner or later come into very wide use for the performance of routine analysis, where it is especially convenient. It is rather remarkable that, as far as output of literature is any criterion, the method seems to be somewhat neglected in America.

Industrial Applications of X-Rays.—The Department of Scientific and Industrial Research has published a small pamphlet on "The Application of X-ray Crystal Analysis to Industrial Problems," while V. E. Pullin,[23] in a paper read at the end of 1930 before the Institution of Mechanical Engineers ("X-rays in Engineering Practice") has dealt among other matters with the application of this method of investigation to casting and welding practice. X-ray outfits have been installed by the Aluminium Co. of America in two of their foundries, in part for routine inspection, as well as for the study of casting problems. The possibilities of applying radiological methods of investigation and inspection on the German State Railways, both in the examination of material in the shops, and also (by means of a mobile X-ray installation) of locomotives, etc., on any part of the system, are being explored.[24] W. H. Shipman[25] reports that at the Barberton plant of Babcock and Wilcox, in order to guarantee reliability of welded boiler drums, etc., 100% X-ray inspection of all longitudinal and girth seams is resorted to. He states that inspection is not prohibitive in cost as compared to the cost of the product. The X-ray inspection of aluminium alloy castings and forgings has been discussed by Hypher[62] in this journal.

A novel method of radiological examination, using gamma rays from radium instead of X-rays, is being developed by various investigators in the United States Navy Department.[26] This method is being successfully applied to the inspection of welds and castings. Excellent radiographs of brass and bronze castings have been obtained.

19 and 20 *Proc. Inst. Met.*, 1931, *46*, 97–138.
23 Pullin, *Engineering*, December 19, 1930, *130*, pp. 785–788 ; *J. Inst. Met.*, February, 1931, *47*, pp. III–IX.
24 Kantner and Herr, *Metallwirtschaft*, 1931, *10*, pp. 717–720, 736–740.
25 Shipman *Amer. Machinist* December 12, 1931, *75*, pp. 708–709.
62 Hypher, METALLURGIA March, 1931, *3*, pp. 159–161.
26 *Amer. Machinist*, 1931, *75*, pp. 278–280, and various papers before the Radiological Soc. of North America.

Manufacturing Processes.

Concurrently with the development of new materials and new processes as the result of pure research work, modifications of production methods and plant are continuously proceeding as scientific knowledge increases. Such modifications are in some cases the result of engineering rather than of purely metallurgical advances, but in so far as they affect metallurgical practice they are included in this review.

Casting Practice.—In the field of the casting of large ingots and billets, one of the most notable developments is the increasing use of water-cooled moulds. The copper-faced mould is not new in itself, but is being increasingly utilised for novel purposes. A recent article by Hessenbruch and Bottenberg[27] gives details of the experimental casting of steel billets in copper-faced water-cooled moulds, and compares the quality of the resulting castings with that of billets cast in iron moulds in the usual way. The fundamental physical considerations underlying the use of copper-faced water-cooled moulds of the Junker type have been reviewed by Roth.

During the past year a novel type of water-cooled mould has been patented in this country by Erichsen.[28] In this case, instead of facing the mould with a material of high thermal conductivity such as copper, plates of a nickel-chromium-iron alloy of very low thermal conductivity are used. These are distorted by means of clamps, so as to be concave on the inner faces, and it is claimed that on pouring the thermal stresses set up cause the plates to bulge inwards and compress the ingot during solidification, thus eliminating shrinkage cavities. This mould is, however, only in the experimental stage, and no information is available as to its commercial life or utility.

In the preparation of small castings the use of die-casting is extending to the detriment of sand casting. Pressure-die casting machines are being developed for use with high-melting-point alloys such as brass, the latest of these being that devised by Eckert.[29] There is also an increasing tendency to replace small castings by worked materials where practicable, owing to the improved soundness and mechanical properties obtained. The relative merits of extruded and cast metal were discussed in an article in the *Brass World*, 1931, *27*, p. 38, and die-pressing is similarly compared (to its advantage) with sand casting by Freeman.[30]

Degasification.—One of the most pressing problems in general foundry work is the attainment of soundness in the castings produced, and in this regard the influence of dissolved gases is being carefully investigated. Much that has been done in this matter during the past year has been concerned with the achievement of soundness in castings of aluminium and its alloys. Towards the end of 1930, Rosenhain, Grogan and Schofield demonstrated the beneficial results which accrue from treatment of the molten metal prior to pouring with certain volatile chlorides, notably titanium tetrachloride ; and Hanson and Slater[41] have carried work in this field a stage further by an experimental review of various suggested methods of degasification. In a second paper[42] they have advanced a very

27 Hessenbruch and Bottenberg, *K.W. Inst. Eisenforschung*, 1931, *13* (*18*), pp. 205–213.
28 British Patent 358,697.
29 Eckert, *Giesserei*, 1931, *18* p. 147.
30 Freeman, *Amer. Inst. Min. Met. Eng. Tech. Pub. 391*, February, 1931.
41 Hanson and Slater, *Proc. Inst. Met.*, 1931, *46*, pp. 186–215.
42 Ibid., pp. 216–237.

interesting theory as to the origin of the gas held in solution in the metal, and have produced considerable experimental evidence bearing on this. Further developments on these lines are awaited with interest. The beneficial influence of treating molten aluminium alloys with a mixture of chlorine and nitrogen, to which Hanson and Slater refer, is also dealt with in some detail by Koch.[43]

In contradistinction to methods such as these, whereby attempts are made to remove the dissolved gases from solution prior to pouring, a novel and interesting method of casting various aluminium alloys under high pressures (up to 20,000 atmospheres) is described by Welter.[44] It appears that in this case dissolved gases are retained in the solid metal, and the author claims that solidification under these conditions results in greatly improved mechanical properties.

Rolling Mills.—Certain improvements in rolling-mill design which are worthy of mention have been made during the past year, the tendency in this connection being towards more rapid output from more or less continuous mills. Of these types some of the most interesting are the continuous wire and strip mills devised by Rohn,[31] and the Stoeckel mill.[32] The latter is somewhat unusual in principle in that the sheet is drawn through the rolls in a manner similar to the wire-drawing operation. The design of mills for heavier duty imposes more serious tasks on the bearings, and Rohn[33] has emphasised the importance of cooling these, as well as demonstrating the superiority of bearings of forged bronze over the usual cast bearings.

Bright Annealing.—The control of the atmosphere in annealing furnaces to secure freedom from oxidation is the subject of much research. The recent progress made in the design of furnaces for bright annealing is reviewed by Kloninger, Keller, and Meuche.[45] The General Electric Co. of America have been active in this field, and have devised a method of utilising cracked illuminating gas (electrolene) for either copper brazing or bright annealing. The American Gas Association have also carried out valuable investigations[46] on the use of either a hydrocarbon gas or a mixture of flue gas and methyl alcohol.

Use of Non-ferrous Metals in Building.

The use of non-ferrous metals in architecture is extending considerably for purposes which in some cases are entirely novel. Copper water pipes, boilers and roofing[49] are not in themselves new, but their field of usefulness is becoming more generally recognised. The all-copper house which is being manufactured by the Hirsch Kupfer and Messingwerke is, however, an interesting and radical departure from orthodox building procedure. Lead will probably always hold an important place in building, particularly for plumbing fixtures, but there is a growing tendency to replace pure lead by stronger lead-rich alloys. It is of interest in this connection to note that the Manchester Corporation are permitting the use of water pipes made of certain ternary alloys of lead patented by the British Non-Ferrous Metals Research Association.[50] These alloy pipes are accepted with a weight per yard of only two-thirds that of the standard weight of ordinary lead, according to the higher strength/weight ratio of the alloys as compared with lead.

Some of the most important developments in constructional work concern the use of aluminium alloys. In America an aluminium alloy containing about 1% each of manganese and magnesium is used for building construction and it is stated that more than 130,000 lb. of this material were used in the construction of Cleveland Municipal Stadium.[51] Aluminium is also being used increasingly for roofing purposes, and its value for this as compared with copper and zinc is discussed by Froidevaux. A detailed account of the methods of use of copper for roofing is given in *Cuivre et Laiton*.[52]

Mercury for Power Production.—A remarkable application of mercury is its use in a mercury vapour-steam cycle for power production. The practical difficulties which must be faced in operating such a system are obvious, but it works at a higher temperature than water at the same pressure, thus giving a more efficient heat engine, and resulting in a considerable saving of fuel. A plant at Hartford (U.S.) using 60 tons of mercury is already in operation, while at the beginning of the year it was reported that a plant of double the generating capacity (20,000 kilowatts) was being erected at Schenectady.[16]

Decorative Finishes.—Though progress is in some respects disappointingly slow, examination of the possibilities in the decorative colouring of metal surfaces is receiving more attention. This is particularly true of aluminium, to the decorative treatment of which much attention has been paid. Very successful results are attainable with this metal and its alloys by certain treatments, which are very ably reviewed in a publication issued by the British Aluminium Co. The production of oxidised copper, brass and silver finishes on aluminium and its alloys by first plating with these metals and subsequently treating to give the required effects is discussed by Pettit.[47] Little fresh work seems to have been done on the decorative treatment of other non-ferrous metals, though the colouring of cadmium deposits has been dealt with in various papers published by Krause.[48]

Miscellaneous.

Exposure to a rotating magnetic field has been found by E. G. Herbert[53] to give rise to an increase in the hardness of metals. Brass and Duralumin were among the materials examined. In a later extension of this work[54] the same author finds that the periodic fluctuations of hardness which occur in metals rotated in magnetic fields or on drastic thermal or mechanical treatment, may be arrested at any desired phase by a method of magnetic stabilisation.

Very great activity has been shown in the development and application of hard alloys for use in cutting tools. The use of tungsten carbide (known as "Widia" and by other names) is rapidly extending, and a new development is the production of tantalum carbide bonded with nickel (under the name "Ramet"). The latter is said to have melting point 4,000° C.[55] Papers have appeared comparing the properties of the tungsten and tantalum carbide products,[56] and giving the results of a questionnaire on industrial experience with hard alloys.[57]

The welding of non-ferrous metals is developing apace. The production of deoxidised copper sheet for welding purposes has advanced considerably, which is a matter of great interest in view of the known excellent welding properties of this material. The welding of Everdur has been referred to above. A series of papers by Goldmann on "Metallographic Aspects of the Resistance Welding of Non-ferrous Metals," in which a very wide range of metals are under examination, is being published.[58] Schuppel and Kastner[59] have investigated the best methods of welding Monel metal, with tests on the corrosion-resistance of the weld. The present position of the autogenous welding of lead and its alloys has been discussed by Partington.[60] K. H. Logan[61] has published a long and important account of the soil-corrosion of numerous non-ferrous metals and alloys, examined after exposure to soil for 4—6 years.

43 Koch, *Z. Metallkunde*, 1931, *23*, p. 95.
44 Welter, *Z. Metallkunde*, 1931, *23*, pp. 255–260.
31 Rohn, *Met. Ind. (Lond.)*, 1931, 39, pp. 461–464.
32 *Heat Treating and Forging*, June, 1931, *17*, p. 559.
33 Rohn, *Z. Metallkunde*, 1931, *23*, pp. 77–86.
45 Kloninger, Keller and Meuche, *Proc. Inst. Met.*, 1931, *46*, p. 537
46 R. J. Cowan, *Met. Ind. (N.Y.)*, 1931, *29*, p. 333.
49 Frith, *Met. Ind. (Lond.)*, 1931, *38*, p. 245.
50 *Plumbing Trade Journal*, 1931, *10*, p. 285.
51 Bossert and Nock, *Metals and Alloys*, 1931, 2, p. 238.
52 Nov. 15, 1931, *4* (67), p. 519.
47 Pettit, *Monthly Rev. Amer. Electroplaters' Soc.*, Dec. 1930, *17*, pp. 9–13.
48 Krause, *Z. Metallkunde*, Oct., 1931 *23*, pp. 283–285; *Chem.-Z.*, 1931, *55*, pp. 845–846, 862–864.
53 Herbert, *Proc. Roy. Soc. A*, 1931, *130A*, pp. 514–523; METALLURGIA April, 1931, *3*, pp. 219–221, May June, 1931, *4*, pp. 9–13, 47–50.
54 Herbert, METALLURGIA, Nov., 1931, *5*, pp. 15–16, 25.
55 *Metals and Alloys (abstracts section)*, 1931, *2*, p. 32; *Metal Progress*, Mar. 1931, pp. 53–55.
56 Kelley, *Amer. Soc. Steel Treating Preprint 14*, Sept., 1931.
57 Sellars, *Amer. Soc. Mech. Eng. Preprint 42*, Nov. 30, 1931.
58 *Elektroschweissung*, 1931, *2*, pp. 195–201 217–221.
59 Schuppel and Kastner, *Z. Metallkunde*, 1931, *23*, pp 286–289.
60 Partington, *Welding J.*, 1931, *28*, pp. 304–310.
61 Logan, *Bur. Standards J. Research*, 1931, *7*, 585–605.
16 *Gen. Elect. Review*, 1931, *34*, pp. 10–12 142.

The New Alloys and——— Machine-tool Design

By Francis W. Shaw, M.I.P.E.

Part VI.—Measuring Devices.*

Means for accelerating measuring are discussed. It is shown that direct measurement is rapidly yielding to measurement by comparison with master-pieces or accurate standards.

TO safeguard against every possibility of error would be exceedingly difficult, but it is certain that either 2-point or 3-point gauges, used in combination, will detect the majority of errors likely to occur in most machining processes. Certain combinations of points and planes, too, afford a good solution to a trying problem, as Messrs. Krupp, of Essen, seem to have realised in constructing their Mikrotast gauges upon the principle of combining two planes and a point—for external gauging, at least.

Krupp "Mikrotast" Gauges for External Gauging.

The Krupp Mikrotast external gauges comprise an indicator—the Mikrotast—and a saddle or frame carrying two fixed gauge points, and forming a guide for the moving gauge-point which communicates with the mechanism of the Mikrotast, and, in moving, actuates the pointer of the indicator. All contact-points are faced with "Widia" metal, a Krupp product.

the adjustable gauge-blocks being, however, set to the standard angle of 39°, instead of the angle of 36°, to which they must be set for gauging the 5-fluted reamer, which the illustration shows as a suitable object for gauging by these instruments—a difficult subject for other measuring devices.

Fig. 46 shows how, in saddles for large diameters, the gauge-blocks are set at a larger angle, the angle here being 90°. In Fig. 50 the instrument is applied to the work as would be an ordinary snap-gauge, but unlike the snap-gauge can be used for gauging rotating pieces. In Fig. 51 the saddle (the vee-shaped upper member) can be raised by depressing the thumb lever, seen below the Mikrotast, to allow the instrument to be removed from the work-piece, here undergoing the operation of grinding. The adjustable lever, reposing on the machine bed, prevents the instrument from turning with the work-piece. The device is as easy to handle as any other gauge, and has the advantage that it need not be removed during the operation.

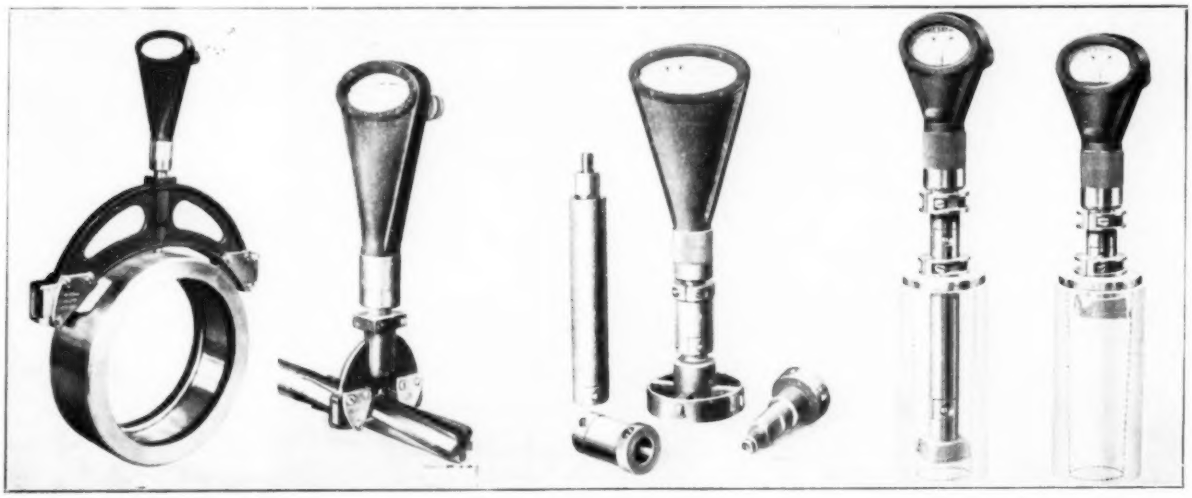


FIG. 46. FIG. 47. FIG. 48. FIG. 49.

Fig. 46.—Krupp "Mikrotast" gauge for large diameters has its gauge-blocks set at an angle of 90°. Differences in diameter are registered at the dial by the radial movement of a contact bar midway between the blocks. All contact points are of "Widia" tungsten-carbide. Fig. 47.—Krupp "Mikrotast" gauge for small diameters, here shown gauging a 5-fluted reamer—a difficult subject for ordinary gauges. Fig. 48.—Krupp internal "Mikrotast" gauge with interchangeable gauging heads and lengthening bar for deep holes. Each head has three fixed gauge-points and a radially moving point connecting to the clock indicator. Fig. 49.—Krupp internal gauges set to gauge a taper hole at two points in its depth.

The Mikrotast operates upon the principle of the multiplying lever, the point of novelty in this instrument being that the levers rock upon knife edges, rendering them extremely sensitive. So sensitive, indeed, is the mechanism that deviations in the diameter of the work-piece so little as a twenty-fifth of a thousandth of an inch are visible at the "clock."

A feature of convenience is the adjustable limit points, coloured red for visibility's sake, which are capable not only of being set to cover the total tolerance, but to indicate its distribution about the nominal dimension. That is to say, the setting may be made to indicate a tolerance that is all plus or all minus, or partly plus and partly minus.

Saddles of divers types are provided according to the use to which the instrument is to be put. In gauges for small diameters the saddle is of the form shown in Fig. 47,

* *Continued from December issue, page 61.*

The angles at which the gauge-blocks are set in normal instruments are those at which the piece, as it is reduced in diameter, influences the movement of the moving contact piece to the same degree as the diameter changes, or in some simple relation thereto.

Internal Gauging.

Internal gauging is a problem quite distinct from external, for the application of plane gauging surfaces to hollow cylinders is impossible. If, then, what has been said under "Difficulty of Detecting Cylindricity Errors" holds true—that any number of fixed points lying anyhow in a circle, will pass some uncylindrical shapes as cylindrical—it is certain that no current-measuring devices, as we know them, are theoretically beyond suspicion.

Whether Messrs. Krupp, in condemning 2-point and 3-point gauges as capable of passing lobate figures such as

Fig. 50.—Krupp indicating snap gauge. It can be used on rotating work, unlike an ordinary snap gauge.

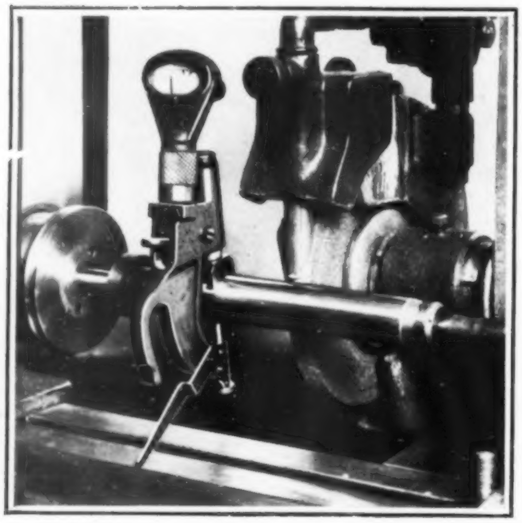


Fig. 51.—New-type Krupp " Mikrotast " gauge in which the gauge-blocks repose on the work (rotating or stationary). To enable it to be removed from the work, the operator presses the thumb-lever so raising the gauge-blocks.

B, C, and D, are aware that 4-point gauges cannot find any difference between E and a circle (see Fig. 45), we do not know, but the fact is that, in certain of its arrangements, the Krupp internal gauge is virtually either a 4-point gauge or a 3-point gauge, according to the way we look at it. Three fixed points, A, B, and C, Fig. 52, tungsten-carbide-faced, guide the gauge, so that the points B and D may lie close to a diameter. The distance from A to C is slightly less than the desired diameter of the hole. The point D moves radially and actuates the indicator.

Now, since when the points A and C can pass into the hole without appreciable side-play, the four points are equi-spaced in a circle, the gauge can be regarded as a 4-point gauge, and, as such, will fit equally well at any position in a hole shaped as E. As the hole is increased the contact may be regarded as 3-point, the contact points being D, A, and B. But Messrs. Krupp condemn 3-point gauges ! And, obviously, if the points are arranged at three corners of a square, they must pass at least the same error as a point at each corner of a square.

The " Mikrotast " Internal Gauges.

The gauge comprises a Mikrotast, gauging heads of divers forms and sizes, extension bars, and means for attaching these last to the Mikrotast. As has been said, the gauging heads carry three fixed gauging or guiding points and a moving measuring point, all as Fig. 48 illustrates. Fig. 49 shows two gauges, one adjusted to gauge the bottom end of a taper hole, the other the upper end. In the event of any suspicion that the process is liable to produce inaccuracies between the extremities of the hole, a third or a fourth gauge would be employed, correctly set for the different depths and diameters. As will be seen, special discs locate both instruments from the same point at the mouth of the hole. The instruments would initially be set to an accurate master, such as those supplied by the makers of taper-shank cutters. For parallel holes, of course, a single gauge only is needed. We must not forget to add that the Mikrotast itself can be transferred from gauge to gauge, but that upon transference it is necessary to reset the Mikrotast to the concerned master.

Gauging Taper Pieces.

To gauge a taper object by ordinary means is not easy, and, too often in the interests of accuracy, is dependent upon feel or upon judgment from frictional marking of the work-piece by a taper-gauge. From a time-saving point of view the case for the better-means instruments, such as Mikrotast gauges provide, is amply justified.

A pair of Mikrotast gauges, connected by a bridge-piece, and provided with a hinged stop, as Fig. 53 illustrates, not only checks the diameters at separated points, but the diameter at a definite distance from some point in the length of the piece. The master to which both Microtasts and the stop have been adjusted is seen reposing on a pair of jacks.

A pair of Mikrotasts with a number of interchangeable bridge-pieces, saddles, and stops—all standardised—cover all the usual standard tapers such as the Morse. The range covered is, indeed, so wide that it is certain that the complete set would be far less depletive of capital than would be ordinary gauges to cover the same range.

Internal taper gauging has been covered under the previous heading.

Index to British Standard Specifications.

A complete subject index to British Standard Specifications has just been issued, which, in view of the large number of specifications of the British Standard Institution now available, will be of considerable assistance to those purchasing engineering and allied material, apparatus, and machinery. The specifications are also listed numerically.

The wide range of subjects covered by the British Standard Specifications is indicated by this indexed list, which covers 40 pages, and, in view of the advantages experienced in the preparation of contracts and tenders, it should be in the hands of all drawing-offices and contract departments of public authorities and firms throughout the engineering, building, chemical, and allied industries.

It may be mentioned that in order to assist the wider adoption of British Standard Specifications, the Institution have again taken accommodation at the Birmingham section of the British Industries Fair, where copies of the 1932 index will be available both for reference and sale. Copies are also available from the Publications Department, British Standards Institution, 28, Victoria St., London, S.W. 1. Price, 1s. 2d. post free.

Fig. 52.—Illustrates principle of gauging by Krupp internal gauges.

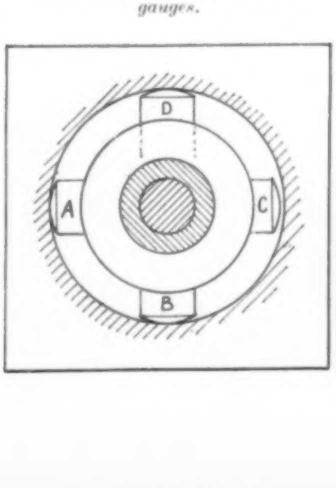
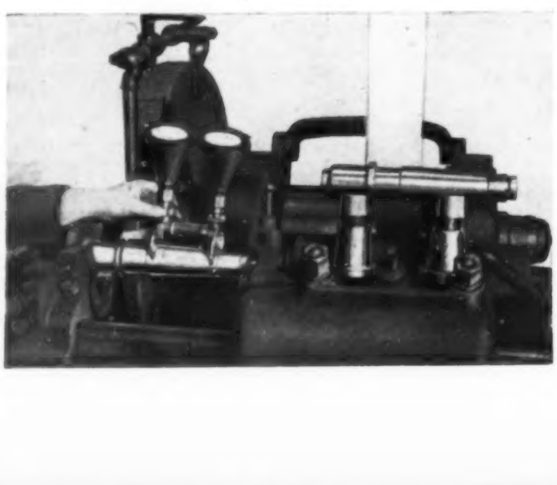


Fig. 53.—Two " Mikrotast " gauges connected and provided with an end-positioning stop for gauging external tapers.



The Bessemer Process

by Jas. Cunningham, Wh. Sch.

Operating results from German Converters.

Consideration of the Bessemer process is opportune, and in the light of German experience this method of steel manufacture offers distinct possibilities.

IN view of the history of the Bessemer and open-hearth processes for making steel, the present position is of distinct interest. The early experiments of Siemens in this country were abandoned at a time when Bessemer was proving successful. His success was, however, of a qualified nature, and the open-hearth process was consequently further developed by the Martins, on proposals of Siemens, to overcome some of the disadvantages. To-day the benefits due to the greater control of product in Siemen's furnaces is generally acknowledged. For long steel produced in the latter has been accepted for many purposes for which converter steel was ruled out. At the same time, the Bessemer process was not neglected, considerable progress being made, especially on the Continent and in America, and also in this country of late years in connection with the manufacture of castings.

The possibility of changes in the fiscal policy of this country, foreshadowed by the recent political events, makes the consideration of this process of particular interest at the moment. The attention of the steel industry was again directed to it by the paper presented to the Iron and Steel Institute last spring by Mr. V. Harbord.[1] In the paper, and in the discussion which followed it, both the financial and the metallurgical sides were dealt with. It was pointed out that a considerable tonnage of basic Bessemer steel was imported from the Continent, certainly assisted by the low price, but also due to some extent to a preference for this class of steel for certain types of manufacture. Reference was made to earlier experience here, which was not of a nature to encourage further attempts to make basic converter steel. On the other hand, it was shown that the technique of the process had advanced very materially in the meantime, and that there was now much more knowledge and experience available. On the metallurgical side this had been in the direction of the use of a wider range of raw materials, the control of the conversion of these into steel, and the subsequent treatment of the steel to secure the best results.

More recently Professor Richard S. McCaffery, in a paper[2] before the American Iron and Steel Institute last October, reviewed the position in the United States. There, owing to the large quantities of suitable ores available, the acid process was developed. For a time it fell into the background, but very pronounced recovery has been in evidence during the last few years. Professor McCaffery stated that not only does (acid) Bessemer steel retain its place for those uses where it has always been pre-eminent, but it has successfully replaced other steels in some of the newer uses. In principle the process is unchanged, but the practice in many respects is quite different from that of only a few years ago. This is especially noticeable in details, resulting from the correlation of operating factors and the results obtained, which has led to the control of these factors to ensure the attainment of the desired results. The refinements introduced all tend towards uniformity of product and improvement in quality. In regard to the actual steelmaking, these are effected particularly by control of the silicon and the initial temperature. In the case of acid, as with basic Bessemer steel, the quality of the final product depends not only on the analysis of the steel as it leaves the converter. Intelligent control is required in the subsequent operations of casting and hot and cold working, the properties obtained and treatment necessary being different from those for open-hearth and other steels of similar compositions.

Two reports lately issued by the Steelworks Committee of the Association of German Ironmasters come at an appropriate time. The first of these[3] gives particulars of the dimensions and operating results, from the replies to a questionnaire sent to 17 basic Bessemer works. These works have 86 converters, and include 25 different types as regards capacity and dimensions. The information is presented in numerous tables and diagrams. The number of converters varies from 3 to 7 in the different works, between 4 and 6 being usual. The capacity ranges from 12 to 40 tons, half of the converters being between 19 and 25 tons, and 13 of them exceeding the latter figure.

The second report[4] consists of a *résumé* of the discussion on the first one, arranged under various headings and giving further information on a number of points. The analysis of the tabulated data, while showing broad lines of agreement and tendencies in development, also indicates the differences in operating conditions which prevent definite conclusions being drawn regarding details, and the necessity for further investigations.

Mixer.

A similar report on the operation and dimensions of mixers was made by E. Herzog[5] in 1929, and consequently these are not dealt with except as regards the capacity of those in use at the different works. A method has been found by E. Spetzler, of which further particulars will shortly be published, for removal of sulphur by adding lime in the mixer to increase the basicity of the slag. Another method employed with advantage for this purpose is to tap from the mixer in the thinnest possible stream, which favours the formation of sulphur dioxide, sieved ferro-manganese, which cannot be used for other purposes, being mixed with lime dust and added in the ladle during pouring.

Casting.

The general practice is to use casting pits, only in three works is 80 to 100% of the product cast into moulds on cars. A question which is the subject of much debate is that of top or bottom pouring of basic Bessemer steel. In most cases top pouring is adopted for hard as well as for soft steels. The construction of the mould cars often compels the adoption of top pouring. In one works which used both top and bottom pouring with 8 to 14 ingots per car, bottom instead of top pouring had recently been adopted for rail steel. The rolling of rail and other hard steels had been transferred to another mill plant, when it was found that the down-cast ingots were more liable to fracture; it is true that at the same time silicon steel was adopted for the rails, which also influenced the change to bottom pouring. At a neighbouring works rail steel is also bottom poured. Since the top-poured ingots are cheaper, efforts were made in this case to use them. In spite of low tapping temperature and small nozzles, it was

1 "The Basic Bessemer Process: Some Considerations of its Possibilities in England." *Journ. I. and S. Inst.*, vol. cxxiii, 1930.—I.

2 "The Bessemer Process and its Product." *Blast Furnace and Steel Plant*, Nov. and Dec., 1931.

3 "Ueber Abmessungen und Betriebsverhältnisse deutscher Thomaskonverter.' Report No. 215. "*Stahl und Eisen*," Sept. 3 and 10, 1931.

4 "Erfahrungen im Thomasbetrieb." Report No. 219. "*Stahl und Eisen*," Dec. 17, 1931.

5 Report No. 175 of the Steelworks' Committee. "*Stahl und Eisen*," vol. 49 (1929). pp. 1361/70 and 1398/1405.

not found possible to secure as good results as with the up-cast ingots. The reason for this was held to be the height of the ingots, which was 2·6 m. or 8 ft. 6½ in.

At a third works, on the contrary, silicon rail steel is always down-cast, experiments having shown that up-cast ingots did not roll so well. A neighbouring works has given definite preference to bottom pouring for rimming steel, in spite of the greater cost, which is there found to amount to about 6d. per ton (at normal rate of exchange for large ingots. Here the best results with killed steel) are obtained by top pouring.

In using bottom pouring with mould cars, it is essential that the cars should be moved very little, or that the rail track should be faultless, to prevent shaking of the bottom bricks and runner. It is stated that such a track has so far only been provided in one works in Germany. The cars are heavy, fitted with roller bearings, and run on a broad gauge track, there being no appreciable shaking.

Production.

The possible output of the various converters when producing soft steels (under 0·3% carbon) was given as from 34 to approximately 240 tons per hour. When making rail or hard steel the output was usually somewhat less, occasionally by 10%, often, however, both more and less. The number of heats in 24 hours was about 40 for 15 to 17-ton converters, and about 33 for those having a capacity of 20 tons and more. It was pointed out that these figures could not be used to draw conclusions regarding the relative blowing times for small and large converters, being dependent on many other factors besides the capacity. For instance, at one works at which it was possible to blow three converters at once (and heat up other two at the same time) about 45 heats averaging 29 tons were obtained per converter in the 24 hours. This plant had six converters with a capacity of 27 tons on a new lining and 31 tons when worn, and a seventh converter with capacities of 34 and 38 tons respectively. The usual sizes of ingots cast were 3 to 5 tons in soft steel (up-cast) and 5 tons in hard steel (down-cast).

The yield of steel averaged about 88 to 89% of the metallic charge. The blowing conditions being less favourable with a new lining than when it is worn, the yield is nearly always less—according to one works the difference amounts to 3%. A uniform method of comparing the yield of different works is desirable. The booking of the metallic scrap used and produced, including short-run ingots, and estimation of the metal content of the slag, present difficulties in ordinary continuous works operation.

Lime.

An excess of lime is generally used, the variation being so great that the conclusion cannot be drawn that it is due to the quality of the steel, or the class, whether hard or soft. A rough calculation shows from 38 to 82% excess, and suggests that the amount of lime is on occasion higher than necessary. The quality of the lime is of considerable importance, since decomposition of both carbon dioxide and water in the bath of metal exercises a chemically unfavourable influence, causing increased loss by ejection of metal, apart from reducing the quantity of net calcium oxide. According to the experience of one works, an iron high in silicon can be fairly satisfactorily blown by using only lime containing 90% calcium oxide, although there is difficulty in introducing the necessary quantities of scrap. If poor lime is used with the poor iron, the loss by ejection becomes enormous, and goes up to 30%.

It is noted that the works using the lowest lime excess calls attention to the determination of the "free" lime as a factor in controlling the amount. No difficulty is experienced in removing phosphorus due to the small excess of lime, but an increment of sulphur is noted, especially when using low sulphur iron. At one works the lime additions have for some time been weighed. This has led to a reduction of 13% in the consumption of lime, with exceptional uniformity of the slag.

Pig Iron.

It is worthy of note that a number of works did not give the carbon content of the pig iron used, suggesting that this was not considered of importance by them. The values given varied between 2·9 and 3·75%, with an average of 3·5 to 3·6%. As a general rule, the silicon content, from 0·2 to 0·59% and only in two cases exceeding 0·4%, was kept as low as possible on account of the effects on the fluidity of the bath, the chemical reactions, and the loss by ejected metal. Higher silicon is accompanied by lower sulphur in the pig iron. The latter can also be secured by raising the lime content of the slag, but only at the expense of an increase in the production cost of the pig iron. There should be some best value for the percentage of silicon, which can be determined by comparing the reduction in costs at the blast furnace with the increase in costs at the steel works, due to greater loss by ejected metal. Attention was called from one quarter to the beneficial effect of high silicon in the pig iron on the citric acid solubility of the slag, especially since the addition of sand in the converter totally or partially prevents the removal of sulphur, and can easily lead to excessive sulphur content in the steel. On the other hand, another works reported that they had formerly had an iron containing 0·63% silicon. For about a year, however, an iron had been blown, the monthly average silicon of which was 0·3% with 0·08 to 0·085% sulphur, while the pig-iron temperature had been reduced from 1,220° to 1,200° C. In spite of the lower temperature, the blowing of the iron had been considerably improved. A third works expressed the view that overall economy was best attained when the blast furnace supplied an iron low in silicon and sulphur, avoiding the loss by ejection from the converter.

According to the experience of a fourth works, there is a lower limit for the sulphur in the mixer iron, below which there is little object in going. With 0·1% sulphur in the iron, experience shows that the ingots will contain 0·06% sulphur. With 0·02% sulphur in the iron it has frequently been found that the content in the ingots was 0·02 and even 0·03%, whilst with 0·04 or 0·05% in the iron a reduction takes place.

The manganese varied to a somewhat wide extent between 0·85 and 1·40% (with the exception of a special case with 2·70%), the phosphorus was from 1·65 to 2·1%, and sulphur 0·04 to 0·08%. The temperature entering the converter was given as 1,180° to 1,230° C. (uncorrected).

Scrap.

The yield is closely bound up with the additions of scrap. At one works an arrangement has proved very economical by which the scrap is brought as hot as possible from the billet shears to the converter. The yield has increased to nearly 90%, while the scrap has gone up to 12% of the charge. The time and method of adding the scrap are also important. Good results have followed from the use in the converter of all the metal scrap produced, not merely that from the rolling mills and foundry. One works has found it advantageous to use the ejected metal, since the price allowed for this by the blast furnaces is very low, apart from the fact that it is already steel and not pig iron. In general, the scrap amounts to 4 to 7% of the charge, serving to control the temperature and at the same time reducing the cost.

Deoxidation.

The quantity of manganese used for soft steels shows very considerable variations, between 3 and 5·2 kgs. per ton of steel, the information available not permitting any co-ordination of these figures with the manganese content of the pig iron. The effect of using liquid or solid ferro-manganese is shown by comparing the manganese consumption per ton of 3·59 kgs., the mean of five works

using liquid, with 4·5 kgs., the mean of eight works using solid ferro-manganese, the latter consumption being 28% more than the former. Ignoring the maximum consumption in both cases, however, the average increase in consumption is only 20%. Even so, very considerable differences in experience were given, and also in regard to deoxidation in the converter or in the ladle. As pointed out, the most thorough method of deoxidation is probably the employment of hot ferro-manganese in the converter for preliminary deoxidation, followed by the use of liquid ferro-manganese in the ladle to complete the process.

Dimensions.

With the exception of two which were oval (a third has been altered to oval since the returns were made) all the converters were cylindrical. The total height of the body varied from 5·05 m. for the 12-ton, to 7·5 m. for the 40-ton converter, the outside diameters being respectively 2·75 m. and 4·8 m. The inside diameter of the lower half is usually less than that of the upper portion, the thickness of the lining being greater in order to ensure equal life in spite of greater wear. Very considerable and irregular variations were shown in the detail dimensions. The thickness of the bottom, irrespective of the capacity, varies between 700 mm. and 1,000 mm.

The mean depth of the bath with a new lining is about 620 mm., with variation from 954 mm. down to 515 mm. When the lining is worn this falls to about 430 mm. to 450 mm., the range being from 538 mm. to 280 mm.

The area of the blast inlets rises fairly regularly from 209 sq. cm. for a 12-ton converter, to 456 sq. cm. for a 36-ton one. The arrangements of the holes in the bottom, including the relation between the diameter of the circumscribing circle to that of the converter, were discussed at length. One works reported good results through reducing the diameter of the holes from 16 mm. to 13 mm. At another works the experiment was tried of increasing the area of the blast inlets from 300 sq. cm. to 450 sq. cm. The duration of the blow was reduced by 10%; the loss by ejection was, however, increased to such an extent that the experiment was abandoned. The opposite experience was made at a third works, where the holes were increased from 13 mm. to 16 mm. diameter. This proved successful, and the fear that the holes would be quickly burnt out was found to be groundless; the duration of the blow was substantially reduced without increasing the ejection loss. An attempt to still further increase the diameter to 20 mm. was a failure.

The reports further dealt with the composition and consumption of refractories and tar, the method of lining, life, and repair of linings and bottoms, composition of the slag and citric-acid solubility, the use of cold pig iron to control the temperature, the quantity and pressure of the blast, the absorption of nitrogen by the steel in the converter, etc. The present trade conditions have caused special difficulties due to intermittent working. To meet these one works had increased the phosphorus content to 2 to 2·2%, to secure more fluid and more easily blown charges. This is costly, and further reduces the life of the lining.

Experience has shown that the maximum economic size has not yet been reached, the 40-ton converter having given distinct benefits. The pass tests give 0·25 to 0·3%, manganese and refining is less troublesome. The loss by ejection is also reduced by about 50%, while the duration of the blow is the same as with smaller converters. The consumption of lime is somewhat reduced, while that of scrap is appreciably higher. It naturally depends on the composition of the pig iron, the best proportion attained being 13% of scrap. The life of the bottoms, including the first one, averages 63 heats, with 390 heats for the lining.

Forthcoming Meetings

INSTITUTE OF MECHANICAL ENGINEERS.

Feb. 19. Annual General Meeting (5 30 p.m.). Report of Council for 1931; "Testing of Materials for Service in High Temperature Steam Plant," by R. W. Bailey, B.Sc., A.M.I.Mech.E., and A. M. Roberts, B.Sc., A.M.I.Mech.E.

GRADUATES SECTION.

Feb. 22 "Potential Applications of Pulverized Metals," by H. Heywood, M.Sc.(Eng.).

Mar. 11 Annual Lecture: "The Strength and Behaviour of Steels at High Temperatures," by W. H. Hatfield, D.Met.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS.

Feb. 26. "Combustion of Heavy Oil Engines," by L. J. Le Mesurier and R. Stansfield.

Mar. 2. "Ships' Electrical Equipment," by J. G. Rutherford, B.Sc.

Mar. 16. "Modern Shipbuilding Practice," by N. M. Hunter, Jr., B.Sc.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.

Feb. 23. "Corrosion in Merchant Vessels," by J. Montgomerie, B.Sc., and W. E. Lewis, B.Sc.

INSTITUTE OF METALS.

Mar. 9-10 Twenty-fourth Annual General Meeting to be held in the Hall of Institute of Mechanical Engineers, Storey's Gate, London, S.W.1, (See page 144.)

LONDON SECTION.

Mar. 17. "The Efficacy of Testing Methods," by H. J. Gough, M.B.E., D.Sc., Ph.D.

NORTH EAST COAST SECTION.

Mar. 15. "Refining of Copper," by R. D. Burn, M.Sc.

SCOTTISH SECTION.

Mar. 14. "Some Notes on Condenser Tubes and Their Packings," by J. W. Donaldson, D.Sc.

SHEFFIELD SECTION.

Mar. 4. "Defects in Spoon and Fork Blanks," by W. R. Barclay, O.B.E.

BIRMINGHAM SECTION.

Mar. 3. "Gases in Metals," by S. L. Archbutt.

INSTITUTE OF BRITISH FOUNDRYMEN.

EAST MIDLANDS BRANCH.

Feb. 27. "Methods of Producing Castings," *ex* E. Longden, at Derby.

LANCASHIRE BRANCH.

Mar. 5. "Some Notes on the Centrifugal Casting Process," by J. E. Hurst.

LONDON SECTION.

Feb. 18. "The Italian Foundry Industry," by Dr. Guido Vanzetti, Milan.

LONDON BRANCH (JUNIOR SECTION.)

Feb. 26 Open Discussion of Some Foundry Problems.

MIDDLESBROUGH SECTION.

Feb. 26. "Some Practical Notes on Cupola Plant and Material Control," by W. J. Colton.

SCOTTISH BRANCH.

Mar. 5. "Heat-Treatment- and Other Special Cast Irons," by A. B. Everest, Ph.D., B.Sc.,

SHEFFIELD AND DISTRICT BRANCH.

Feb. 19. "The Use of Pulverised Fuel and Pulverising Machines in the Foundry," by P. Howden.

WALES AND MONMOUTH BRANCH.

Feb. 27. 'Foundry Sundries," by J. J. McClelland.

MANCHESTER METALLURGICAL SOCIETY.

Feb. 17. "Cold Working and Drawing of Steel," by A. T. Adams.

Mar. 2. "Creep of Metals," by Wm. Barr.

AMERICAN SOCIETY OF TESTING MATERIALS.

Mar. 9. Cleveland Region Meeting.

Mar. 7-11 Group Meetings of Committees at Cleveland.

Some Recent Inventions.

A New Machine for Plate Springs.

In the manufacture of plate or leaf springs for motor- and other vehicles, it has been customary to carry out the processes of rutting to length, drawing out the ends, clipping to the desired shape, nibbing, slitting, rubbing, punching and shearing the ends of the plates in separate machines, and where necessary, the heating of the plate between each operation. A new machine has recently been devised by which all these operations can be effected by inserting the necessary tools. With this machine only one heating of the plate is necessary, and any size of plate may be produced within the capacity of the machine.

This machine, front and end elevations of which are shown in Figs. 1 and 2, consists of a bed-plate fitted with slides, a pair of rollers, and two crankshafts A and B, extending the full length of the machine. The crankshaft B is fitted with a driving wheel together with gears, so that crankshaft A is constantly rotating. Five connecting arms C are carried on shaft A, carrying small rams on which are fitted the necessary tools required for various operations. Thus, at D an end clipper, E a nibbling tool, F a punch for elongated holes or sliding tools, and G a tool ror ribbing the plate at the ends. This latter tool consists of a top and bottom member, which are fastened together to allow free movement of the bottom part, and having suitable springs to keep it a full distance.

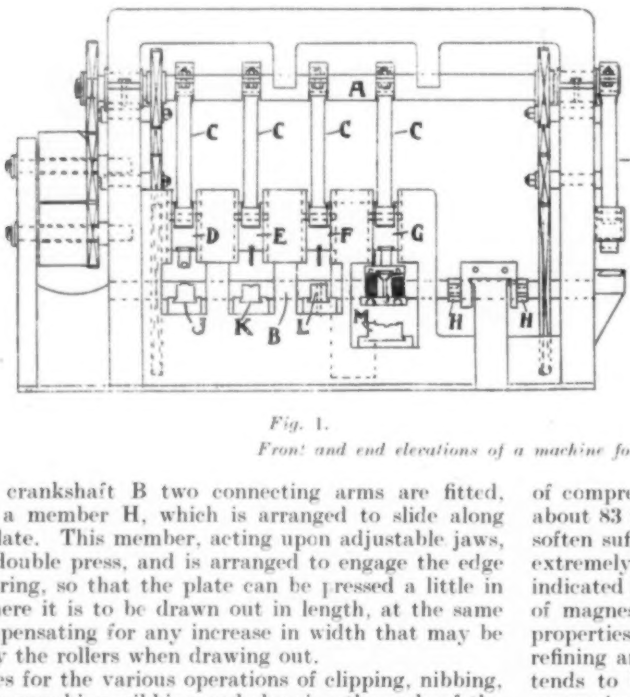


Fig. 1.

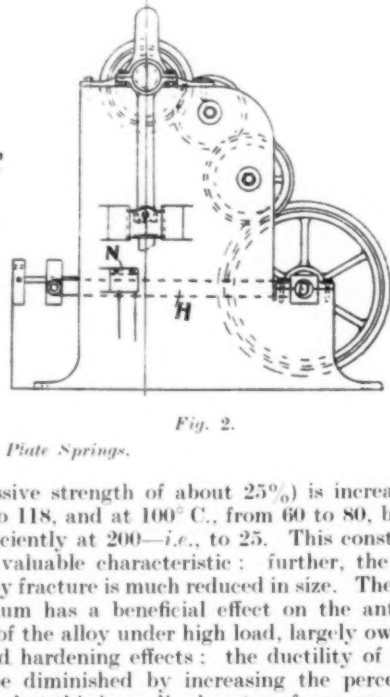


Fig. 2.

Front and end elevations of a machine for Plate Springs.

From crankshaft B two connecting arms are fitted, carrying a member H, which is arranged to slide along the bedplate. This member, acting upon adjustable jaws, forms a double press, and is arranged to engage the edge of the spring, so that the plate can be pressed a little in width where it is to be drawn out in length, at the same time compensating for any increase in width that may be caused by the rollers when drawing out.

The dies for the various operations of clipping, nibbing, slitting or punching, ribbing and shearing the ends of the plates, as at J, K, L, M, and N, are fitted in suitable slides on the bedplate and side frame in such a way as to be rapidly adjusted to suit any desired plate, and stops and limit gauges can be fitted to each die, as well as behind the rollers, to prevent any error in each of the operations.

362,340. Walter Williamson, Oldham Road, Manchester, and William Ryder, Ltd., Bee Hive Works, Bolton, patentees: Messrs. E. K. Dutton and Co., agents. Accepted, December 1, 1931.

An Improved Bearing Alloy.

It is generally recognised that low coefficient of friction, good thermal conductivity, resistance to abrasive wear, and sufficient strength and rigidity to stand up to the duty, are among the more important properties demanded of a bearing metal. The anti-frictional and also the wear-resisting qualities of bearing metals depend, almost entirely on the amount, character, form, and also on the uniform distribution of the segregated particles in the composition and it is important that an alloy for this purpose should be correctly compounded. There are many different bearing alloys, but all may be classified as white metals or bearing bronzes. The former include the tin or lead base bearing alloys, and a recent addition to this class is a zinc base alloy. The basis of composition is zinc, and other constituents added include aluminium, copper, magnesium, and with or without one or more of the following :—nickel, iron, chromium, cobalt, manganese and vanadium. The addition of magnesium is claimed to improve the alloy, enabling it to stand up to higher temperatures, owing to the hardening influence of magnesium, and also to its refining effect : it also stops the tendency of the alloy to wipe, smear or flake under exceptional high temperatures or pressure bearing conditions.

The result of an addition of 0.8% of magnesium is to increase the compression strength by at least 10% at 100° C. above that which the alloy would have without such content. Inter-cellular oxidisation is negligible in these alloys when the copper is within the range of 0.1 to 2.0%. Experiments have shown that an alloy containing about 88% of zinc, 9.0% of aluminium and 1.6% of copper is improved by an addition of 1.35% of magnesium, so that its Brinell hardness at 50° C. (equivalent to an increase of compressive strength of about 25%) is increased from about 83 to 118, and at 100° C., from 60 to 80, but it will soften sufficiently at 200—*i.e.*, to 25. This constitutes an extremely valuable characteristic : further, the grain as indicated by fracture is much reduced in size. The addition of magnesium has a beneficial effect on the anti-friction properties of the alloy under high load, largely owing to its refining and hardening effects : the ductility of the alloy tends to be diminished by increasing the percentage of magnesium, but this is no disadvantage for many purposes.

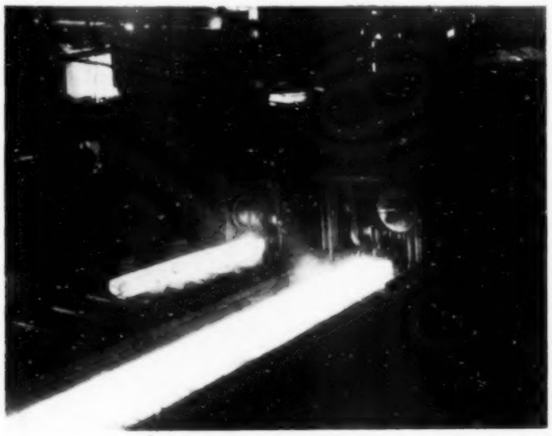
The alloy may be compounded by melting commercial aluminium and adding the copper in the form of 50% copper and 50% aluminium alloy. The other elements which have approximately twice the atomic weight of aluminium, if present, are added as a 10% to 20% alloy with aluminium, about half the zinc is added in a pre-heated condition, then the magnesium is added in metallic form, followed by the other half of the zinc, and preferably after which the alloy should be thoroughly stirred, skimmed and then cast.

362,507. Horace C. Hall, Littleover, Derby, patentees ; Messrs. Claremont Haynes and Co., agents, Vernon House, Sicilian Avenue, Bloomsbury Square, London, W.C.

Recent Developments in Tools and Equipment

Frodingham Complete Their Range of Sections.

Until recently the Frodingham Iron and Steel Co., Ltd., of The United Steel Companies, Ltd., have omitted certain standard beam sections from their comprehensive list, owing to practical difficulties in rolling some of the larger sections in their existing mill. They have recently determined to place themselves in a position to supply the complete range of British Standard Beams, and are now successfully rolling 22 in. × 7 in., and 24 in. × 7½ in. beams. This necessitated certain mill alterations, and as the finishing mill is a 30-in. mill, it will be realised that the rolling of these large sections from a mill of this size is a technical achievement of some interest to readers.



An ingot being shaped at the cogging rolls and first roughing stand of the finishing rolls.

The large section mill at Frodingham comprises a 36-in. cogging mill, and a 30-in. finishing mill of three stands. In addition to supplying blooms and slabs for the finishing mill, the cogging mill supplies blooms and forgings for sale. To roll successfully the 22-in. and 24-in. beams, it was found necessary to design a special pair of cogging rolls, so that part of the work generally done in the roughing-passes in the finishing mill could be done in the cogging mill. The advantages of this method of working are manifest, while the only disadvantage is the necessity to change the cogging rolls every time 22-in. and 24-in. beams are rolled. Efforts were directed, therefore, to reduce the time required for roll changing by certain alterations in the design of the mill. This was accomplished to a very marked degree, and the roll-changing time so reduced that quick delivery of these and other sections is obtained. The three pairs of finishing rolls were so designed that all the passes are alternately closed and open on the flanges, thereby producing a section true to shape.

The process of rolling the beams is as follows :—The ingot is rolled down and shaped in the cogging mill. The ends are sheared, and the shaped bloom is placed in a reheating furnace. It is withdrawn from this furnace at a suitable temperature, and finished to size in the finishing mill. Throughout its working the steel is, therefore, kept at the right temperature to produce ultimately a finished product of first-class quality and shape.

The 24 in. × 7½ in. beams can be rolled in weights ranging from 90 to 108 lbs. per foot, and the 22 in. × 7 in. beams in weights ranging from 75 to 88 lbs. per foot. Three pairs of rolls were designed for the 22 in. × 7 in., and three pairs for the 24 in. × 7½ in., together with one pair for the cogging mill, making altogether seven pairs of rolls, aggregating 160 tons. These rolls are of forged steel, and were made by the associated firm of Messrs. Steel, Peech and Tozer, and delivered complete in three months. They have given every satisfaction in the mills. The illustration shows an ingot being shaped at the cogging rolls, and the shaped bloom at the first roughing stand of the finishing rolls.

The Witton High-Frequency Induction Furnaces (Stobie Patent)

The General Electric Co., Ltd., have recently concluded an agreement with Mr. Victor Stobie by which they acquire the sole rights to manufacture and sell within the Empire high-frequency induction-type electric furnaces in accordance with his patents. The furnaces are claimed to offer many important advantages for the production of high-grade steels, and the melting of ferrous and some non-ferrous metals and alloys. They facilitate the melting of steel and other alloys with such accuracy that the product can be made to any special analysis. In addition, charges melted do not take up sulphur, and high chromium or other alloys which have a strong affinity for carbon are melted without any possibility of carbon addition. The continual movement of the molten charge ensures a uniform product. Further, the cost of operating a high-frequency furnace is unexpectedly low. As a rule, the current consumption is somewhat less than in an arc furnace in proportion to metal melted. In comparison with older methods, melting costs are considerably lower, and steel comparable in quality with the best crucible steel can be produced at approximately half the cost of the crucible process, when costs are based

Fig. 1. Melting position of the Witton High-Frequency Induction Furnace.

on the average rates for electric supply in industrial districts.

Of all the types of furnaces employed in the manufacture of steel, none is easier to manipulate than this type. Automatic control simplifies operation, and there is little

need for labour excepting to charge and pour. In this design every effort has been made to clear the platform of any mechanism likely to impede or endanger the operator, while in construction the crucible and insulation are the only non-metallic parts, and severe shocks, which might cause crumbling in the asbestos-cement type of furnace, do not affect the safety of the operator or the equipment of the Witton furnace.

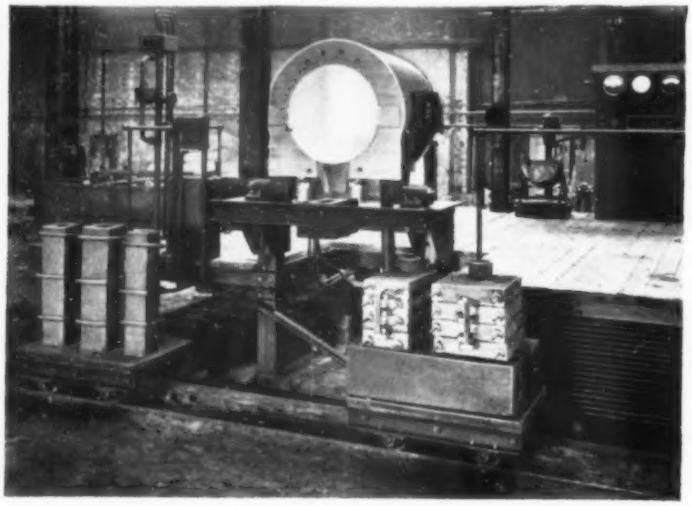


Fig. 2. End of Pour.

This high-frequency induction furnace differs from other high-frequency furnaces in that it is not of the coreless type, but is partially cored. The path for the magnetic field in a Witton furnace is mainly through thin laminations of high-silicon low-carbon steel. This material has a conductivity for magnetic flux immeasurably greater than that of the air path in earlier high-frequency furnaces. This alloy steel magnetic path is brought to a central position right inside the axis of the inductor coil. The result is that, instead of a magnetic field weakened by air resistance and uncontrolled as regards its distribution within the crucible, the electro-magnetic system of this furnace enables so strong and centrally situated a magnetic field to be available in the crucible for inducing the current in the charge, that it has been possible for the remainder of the electrical equipment to be made entirely subservient to considerations of safety and efficiency (both electrical and metallurgical).

The potentialities of this type of furnace are very considerable; at the moment it has a wide field of usefulness in the modern steel foundry, because it favours production at relatively low cost, is capable of delivering molten steel every hour, of any composition desired, and with control that gives the steel an almost perfect condition in the fluid state; but its application to non-ferrous alloys is gradually being more appreciated.

Correspondence.

White-Heart Malleable Iron.

The Editor, Metallurgia.

Sir,—I regret very much that in one or two instances the report of the Manchester Metallurgical Society meeting published in your January issue, is not in accordance with the paper, and if it is possible should like you to make a correction, as no doubt anyone interested in the malleable iron industry will immediately see that wrong information has been given.

It is stated that it was not so necessary to take elaborate precautions in melting as in the production of blackheart malleable. What was stated in the paper was that extreme care had always to be given to the melting, as it was most important. In connection with the sulphur content, I notice you state that a range of 0·02 to 0·2% was the sulphur aimed at. With cupola-melted iron it is impossible to get so low as 0·02, and the metal would contain from 0·15% to 0·3%. The remarks in connection with the considerable amount of free ferrite in the internal structure are, of course, wrong, the ferrite being at the skin of the casting.—Yours, etc.,

Leicester. C. Blades.

The Editor, Metallurgia.

Sir,—I have read the letter from Mr. Blades, and as one who was present at the reading of his paper, I considered your report, condensed as it was, conveyed a fair impression of the facts submitted. Whilst it was generally conceded that the methods of manufacture he described showed the great care needed in getting correct mixings and heatings, the direct cupola-melted metal could not be held in the furnace and analysed, then changed in composition whilst still molten, as is absolutely necessary in the case of air-furnace melted white iron for making black-heart malleable. In this sense it is strictly true that "it is not so necessary to take elaborate precautions for melting," as the cupola can never equal the air furnace in this respect. The question of sulphur content was raised in the subsequent discussion, and from practical experience recommended as advisable to be controlled within the limits stated: 0·02 to 0·2%, but although these theoretical limits were agreed to, the higher range of 0·2 to 0·45% was claimed by the speaker as permissible without any deterioration of the qualities of the resulting metal. The completely free ferrite at the skin of the malleable iron is undoubted, but in the absence of some "considerable amount of free ferrite" associated with the pearlite (and, of course, amorphous graphite) in the core of the casting there would be no "fair amount of ductility in the metal." Every sample of white heart malleable which possessed any ductility and reasonable degree of machinability I have examined microscopically, including those from Mr. Blades, had at least 40% of free ferrite in the core metal. In fact, if there was not this free ferrite in the internal structure the metal would not be malleable, ductility would be almost nil, and machining a very difficult proposition indeed.—Yours, etc.,

Manchester. J. S. Glen Primrose.

The Institute of Metals.

The twenty-fourth annual meeting of the Institute of Metals will be held in the Hall of the Institution of Mechanical Engineers, Storey's Gate, London, on March 9 and 10, at which a comprehensive range of papers will be presented. An innovation in the proceedings is being made by the Council at this meeting. Whilst the ordinary business of the Institute and the reading of papers will occupy the first day and morning of March 10, the second afternoon's session will be devoted to a general discussion on "The Testing of Castings."

A special opportunity is afforded visitors to take part in the discussion at this meeting. Cards of invitation, admitting to the meeting, may be obtained on application to the Secretary, Mr. G. Shaw Scott, M.Sc., F.C.I.S., 36, Victoria Street, Westminster, S.W. 1, who will also supply forms in connection with a membership election that is due to take place on February 18. Persons elected then will have the privilege of membership, not for the usual twelve months, but for the extended period ending June 30, 1933, and will be in a position to take part in the proceedings at the March meeting, at which, in addition to the above-mentioned general discussion, 14 papers will be presented.

Mechanising the Foundry

New Foundry Installations of Messrs. Ferranti Ltd.

Continuity of operation with minimum handling is the primary object of a new mechanised foundry, described in this article, which provides an outstanding example of efficiency.

DESPITE the existing depression in industry and its effect on the economic condition of foundries, there is sufficient evidence to indicate that progressiveness pays. It is during these times of adversity that competition becomes keener, when economic production is only possible by making full use of modern developments in equipment. Many factors would need to be considered to show that a properly equipped foundry can produce economically, while others less efficiently equipped will suffer a loss on similar work, but it is a remarkable fact that where initiative and development have been shown by foundry executives, such foundries are almost producing on a normal scale.

There can be no doubt that a progressive and constructive policy, combined with systematic research, constant experiment, tested materials and skilled workmen, makes the products of the foundry outstanding in regard to cost, reliability, and performance, which improve the prospects of securing contracts, however keen the competition.

In any progressive policy the installation of machinery has an important place, and although opinions differ on the type of machinery most suitable for a given set of conditions, modern requirements necessitate the gradual elimination or considerable reduction of manual work, and at the same time the maintenance of continuous production. Not all foundries can make economic use of continuous plant, but when the castings required are of a repetition character the advantages of this type of plant are worthy of careful consideration. The primary objects of any mechanical appliance are to reduce handling and to maintain continuity of operation, and when the range of work to be produced is known the lay-out of the foundry can be designed to produce an anticipated daily or weekly tonnage.

It is this principle of continuity that underlies the mechanical installations of Messrs. Ferranti, Ltd., in their new foundry, which has recently commenced operations on a production basis. The rapid growth of these works, and the need for additional large constructional bays, has caused the reconstruction of the old foundry building for this purpose. Adequate preparation for this expansion was made about a year ago, when a start was made to build a new foundry. The change over from the old to the new foundry, early this year, was effected over a week-end, without delay in production.

This new foundry is designed to meet the whole of the casting requirements of the firm's wide range of products, and since much of the work is not of a repetition character, the foundry is arranged in two sections, one for dealing with general work and the other for repetition work. Each section is laid out to suit the particular range of work within its scope. In the section dealing with general work the layout conforms to what is accepted as modern practice Castings ranging up to 10 tons may be made in this section, and the moulds may be made in green sand, dry sand, or loam. Power moulding machines are installed, and for the range of work covered this section is quite effectively arranged to give the best results conditions permit. It is the other section, however, which is of special interest, as it provides an excellent example of a mechanised foundry.

The mechanised section is laid out on the straight-line principle, and an outline of the scheme of operations will assist in visualising the layout. A centralised sand-preparing plant supplies sand to hoppers under which operate moulding machines. The prepared moulds are placed on the conveyor table, where they are clamped, and as the table carries them to the precincts of the cupolas, casting then takes place. The cast moulds remain on the table till they reach a knock-out grid through which the sand passes, the castings being placed on a conveyor for transport to a sand-blast apparatus, and the boxes returned

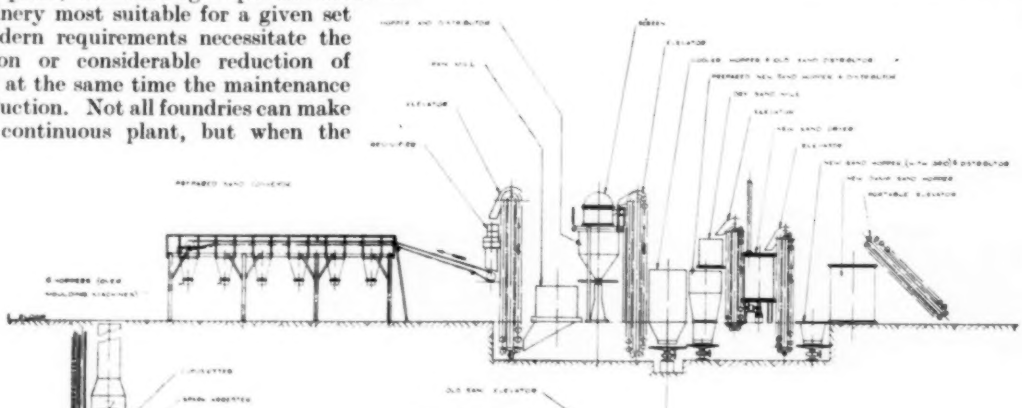


Fig. 1.—A diagrammatic arrangement of the Sand Treating and Moulding Plant

to the moulding machines by a roller conveyor. The sand-blast machine is of the rotary table type, part of which is discharged and loaded as it rotates. The castings after sand-blasting are transported to the grinding and fettling section by means of a band conveyor, and adjoining the grinding section are a number of machine tools for drilling and finishing castings. Facilities for the transport of the finished castings to the lacquering and assembling departments are not yet completed, but it is proposed to stack the castings in specially constructed cage wagons and transport them by electric motor to their respective departments, leaving them to be unloaded during the course of the further operations. In continuous operation the scheme works very smoothly, with the minimum of manual effort.

Sand-treating Plant.

The diagrammatic arrangement of the sand-treating and moulding plant is illustrated in Fig. 1. The upper part of this diagram shows the method of dealing with new sand, which is picked up and deposited in a hopper by means of a portable bucket elevator. The new sand is fed to a second hopper fitted with a grid and distributor. A bucket elevator collects the sand from the distributor and deposits it in a sand dryer. Opinions differ in regard to the need of a dryer for new sand, but there can be no doubt that thoroughly disintegrated new sand is distributed much more evenly after it has been dried. Thus, after being dried the new sand is elevated to a mill for disintegration and the prepared sand is deposited into a hopper, from the bottom of which it is distributed on the old sand distributor. The lower part of the diagram indicates the method of dealing with the old sand from moulding boxes. All casting is done as the conveyor table transports moulds to the vicinity of the cupolas and the castings are knocked out on a special knock-out grid, the sand being deposited in a hopper beneath, the castings being placed on a conveyor for transportation to a sand-blast machine, and the moulding boxes carried by roller conveyor to the moulding machines. A reference to the lower diagram in Fig. 1 will show the collection and distribution of the used sand. From the hopper, immediately under the knock-out grid, the sand passes on to a distributor from which it is fed on a belt conveyor. The belt conveyor passes under a distributor from a coal-dust hopper, and receives coal dust. Both old sand and coal dust are then elevated to a belt conveyor, which deposits them in the old sand hopper, which also acts as a cooler and distributor. The belt conveyor is fitted with a magnetic drum for the removal of all metal from the sand.

It will be noted on reference to the upper diagram that new sand is fed on to the old sand distributor, from which it is elevated to a rotary riddle, having a ¼-in. mesh. The screened sand passes into a hopper and subsequently to a distributor, where water is added before it passes into a pan mill. Finally the milled sand is elevated to a revivifier, the prepared sand being fed on a belt conveyor to hoppers immediately over moulding machines. The illustration, Fig. 2, shows these hoppers as well as the conveyor table for the moulds, but the photograph was taken before the installation of moulding machines and the roller conveyor for the empty moulding boxes had been completed. The belt conveyor for feeding these hoppers is shown in Fig. 3. Both these installations indicate the effective lighting obtained from the glass roof.

The plant is fully continuous in operation, and modifications in the amount of new sand, coal dust, or water in the prepared sand can be made in order to produce the cleanest skin on the castings. The contents of coal dust and moisture particularly are given special attention, and the excellent castings produced bear silent witness to the efficacy of the system employed.

The work produced in this mechanised foundry at the present time may be classified in two ranges—between 4 oz. and 2 lb. in weight, and between 2 lb. and 7 lb.,—and a week's production on these ranges will give about 35,000 castings, having an approximate gross weight of 35 tons. The castings are of very light section, but many are very complicated, involving much coring, so accuracy and skill are necessary in the preparation of the moulds. For this reason only skilled moulders are employed. All moulds are produced on pneumatic moulding machines, which are equipped with turnover and stripping devices, a machine being placed immediately under each treated-sand hopper, fitted with apparatus for discharging sand directly into moulding boxes on the machines. The fabricated moulding boxes are lifted from each moulding machine, and the finished mould is placed on the conveyor table.

A special department is allocated to core-making, and the cores to meet the casting requirements are made the previous day, stacked on special trays and placed on core wagons for baking. Each working morning the wagon is transported by crane to the moulding machine, near to each of which is suspended a cage for storing trays of cores to be used during the course of the day.

Fig. 2.—Showing the Sand Hoppers and Conveyor Table.

Fig. 3.—The Belt Conveyor for feeding the Sand Hoppers.

The conveyor table, which at present travels at 18 ft. per min., is apparently capable of dealing with more moulds than are produced from the six moulding machines, and developments are in progress for making greater use of the table and the sand-preparing plant.

Non-magnetic Cast Iron.

Both ferrous and non-ferrous castings are made in this foundry, but the majority of the work is in cast iron. In the construction of electrical machinery and apparatus, where an alternating or rotating flux is present, it is necessary, in order to avoid hysteresis losses, to use non-magnetic materials. For this purpose a non-magnetic cast iron, known as "Nomag," which is produced under the Ferranti-Dawson patent, is used. This alloy is readily machinable, and in addition to being non-magnetic, it has an increased electrical resistance which gives almost complete freedom from hysteresis and eddy currents. Nomag has been developed with the object of reducing electrical losses, and it is used for such castings as alternator clamp rings and end shields, oil-switch covers, transformer covers, cable boxes, sealing bells, cable clamps and supports, bus-bar clamps, and it has also proved eminently successful in the form of resistance grids, where the increased resistance has enabled the number of grids to be reduced and the spacing increased, thus giving facilities for greater heat radiation.

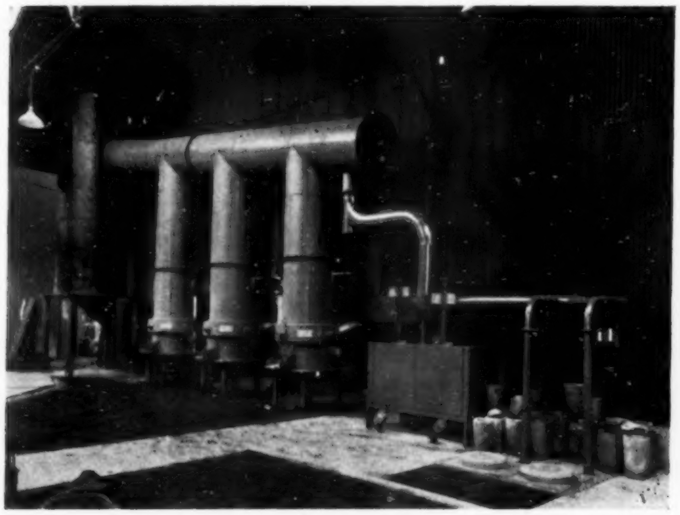


Fig. 4.—Novel arrangement of Cupolas and Non-ferrous Melting Furnaces.

In this material the change-point has been so effectively lowered that on subjecting it to the temperature of liquid air, only a slight degree of magnetic permeability is obtained. The proportions of nickel and manganese which are contained in the alloy have been so arranged to render it as easily machinable as grey iron, but, due to the increased toughness of the alloy, it is advisable to employ tools such as are generally used for mild steel.

Although a good proportion of the work in the foundry is produced in this non-magnetic cast iron, grey iron castings predominate. To achieve success in an iron foundry, when a special alloy of this character occupies so important a place, considerable care must be exercised in the selection and storage of materials and in the composition of the charges to the furnaces. A special storage bay at the end of the foundry is allocated for this purpose, and although not yet completed, the scheme in view is in keeping with the efficient layout of the foundry proper. Amongst the various brands of pig iron used is included special refined pig and special attention is paid to the sorting of foundry scrap. A pig-breaking machine by Greens of Keighley is installed.

Melting Plant.

The melting plant consists of three small cupolas, each 24 in. diameter at the tuyères, which form a battery; one cupola 36 in. diameter at the tuyères and two small cupolettes. In addition, two pit-type furnaces have been constructed, each capable of accommodating crucibles of 200 lb. capacity. These latter are for dealing with non-ferrous metals required from time to time. A reference to Fig. 4 will indicate the position and type of non-ferrous metal melting furnaces. They are designed for coke and are supplied with forced draught, the hot exhaust gases passing through a chamber for heating the crucibles. The battery of three cupolas shown in Fig. 4 are placed at the end of the mechanised section of the foundry. The merging of the three cupolas into one stack with a dust extractor is of special interest. The object is to reduce the contamination of the air by dust, and incidentally to maintain effective lighting from the glazed part of the roof. The dust extractor is fitted with a baffle-plate, and the dust, which accumulates in the chamber, is drawn from the bottom at regular intervals. The thin castings required demand hot fluid metal, and it has been found necessary not only to line the merger pipe, but also the upper part of the dust extractor.

It is only in exceptional instances that the three cupolas would be in operation at one time. The normal practice is to blow one cupola during the morning and have a second ready for blowing during the afternoon. In this way one is always ready for blowing early the following morning. The larger cupola serves the needs of the general section of the foundry, in which the larger castings and those that are not of a repetition character are produced. As all Nomag is remelted for making castings, this cupola is frequently used to melt the mixture of raw materials for Nomag pig. The larger cupola at present is not connected with the dust extractor, but the success achieved in the clean operation of the smaller cupolas is such that a flue connection from the large cupola is contemplated. The smaller cupolettes are primarily for emergency purposes; they are readily put into operation as the need for their use arises.

Research Laboratories.

Adjoining the foundry is a spacious, well-lighted laboratory. It is adequately staffed and equipped for carrying out routine tests and analyses connected with the work of the whole establishment. In addition, ample facilities are afforded for investigation and research. In connection with the foundry, an investigation is at present in progress with the object of developing a simple apparatus for the determination of the moisture content in green sand mixtures. All who are experienced in green-sand work will appreciate the importance of control of the moisture content of the sand used and the desirability of standardising mixtures for different sectioned work that give the best results in practice. The apparatus being devised for this purpose is electrically controlled, and it is expected to be of real practical value.

The whole foundry, particularly the mechanised section, provides an interesting example of progressiveness not commonly associated with foundries in this country, and Messrs. Ferranti, Ltd., are to be congratulated on the maintenance of an advanced policy during a time of depression. Although working on a normal production basis at present, there is no doubt that further structural additions and installations contemplated in this foundry will considerably increase its productive possibilities and give scope for supplying a wider range of castings suitable to the needs of other industries besides electrical.

Business Notes and News

Russian Industrial Plans.

A report recently published in Russia gives particulars of a second five years' industrial plan. The remarkable progress that has resulted from the first five years' plan has prepared an informative and practical basis for further comprehensive developments. Among the outstanding developments of the past period, not the least are the heavy industries, which have been placed on a substantial footing, and will serve as a definite basis for future developments having as their primary object the completition of the reconstruction programme originally decided upon.

The instructions given in this report indicate that the fundamental task imposed is a speedier rise in the standard of living by a rapid growth of the national income. With this object, the second five years' plan is designed to produce at least twice or three times as much as has been produced at the end of the first five-year plan. The report states that the Russian Government realise that the tasks before the people are only possible of accomplishment on a basis of extensive technical reconstruction of the entire national structure, embracing economics, agriculture, industry and transport. The influence of machine design and construction on the success of any technical reconstruction is recognised, and the instructions insist that the output in machinery manufacture at the end of the second five years should be at least three to three and a half times the output during the present year. Considerable attention is given to the proposed erection of a modern power base. A production of not less than 100-milliard kilowatt hours of electric energy is aimed at by 1937, as against a production of 17 milliards reached in 1932, while considerable increase in coal and oil is contemplated. Not the least interesting feature of the report is the reference to increased transport facilities. The second plan includes the complete reorganisation of the railways, and 25,000 to 31,000 kilometres of new tracks must be built, the construction of powerful locomotives and large rolling stock, and the electrification of a number of lines.

British Steel for Canada.

The manager of the British Steel Export Association, Mr. Julian Piggott, in an address before the Royal Empire Society recently stated that adversity had taught the British steel industry to think on national rather than individual lines. He gave an account of a recent visit to Canada which he made with the object of ascertaining the best means of increasing the sales of British steels in Canada without injuring the Canadian steel industry. He found that the Export Association's policy of non-competition with the light structural steel of the Canadian mills, while securing their aid in diverting to the United Kingdom a large proportion of the foreign imports of the heavier lines for the manufacture of which British mills are specially adapted, had also enlisted the sympathy and even the active support of steel makers, as well as big consumers and the Government. He suggested that, under present conditions, it was important to secure as much as possible of the heavier rolling-mill products the majority of which had been supplied by the United States. Mr. Piggott expressed the opinion that the problem of Empire freer trade must be tackled in the first place by industries themselves, to be followed by Government aid in the arrangement of suitable tariff adjustments on the conclusion of agreements mutually satisfactory between industries.

The Iron and Steel Institute Awards.

A limited number of grants from the Carnegie Research Fund are awarded each year by the Council, irrespective of nationality or sex, in aid of original research work. Application must be made before the last day of February, on special forms to be obtained from the Secretary of the Institute. Candidates must be under 35 years of age.

The Williams Prize, which is of the approximate value of £100, is awarded by the Council each year to the author or authors of (British nationality) that paper adjudged to be the best paper of a practical character presented to the Institute, and accepted for publication at any General Meeting during the year. The full conditions of this award can also be obtained from the Secretary of the Institute, 28, Victoria Street, London, S.W. 1.

Shipbuilding Plant Sold.

The plant of the Northumberland Shipbuilding Company's yard at Howden-on-Tyne, has recently been sold. It will be remembered that this yard was one of a number purchased by the National Shipbuilders' Securities, Ltd., in connection with the rationalisation scheme, to be dismantled. This yard was one of the best equipped in the country for the type of merchant vessel in which the firm specialised, and it had a very high reputation for rapid construction. In 1911 the firm launched 13 vessels from five berths, while in November, 1918, the firm accomplished the remarkable feat of completing a vessel of about 9,000 tons deadweight, known as the " War Citadel," in 63 hours after it had been launched. Prices were very low, and many bargains were procured.

Report of Fuel Oil Distribution in the United States.

The Bureau of Mines of the United States Department of Commerce have issued a report which presents statistical data on the distribution, by States and industires, of gas oil and fuel oil in the United States during 1930, and constitutes the fifth consecutive annual compilation of figures on this subject. In this series of annual surveys, the marketing companies have co-operated to furnish detailed information on the distribution of oils sold as industrial and commercial fuel, and the heavier oils sold for domestic heating. The survey, consequently, includes the distribution of heavy domestic crude oil used for fuel, gas oil, foreign fuel and crude oil, and the residual fuel oil produced at refineries.

It is noteworthy that, while decreases of 583,751 barrels in exports to the United Kingdom, 205,675 barrels to Italy, and smaller decreases in exports to Sweden and Denmark are indicated, these are offset by increases of 655,460 barrels to Germany, 114,072 barrels to the Netherlands, and by smaller increases in shipments to France, Belgium, Norway and Spain.

Pneumatic Tyred Rail Coach.

A series of trials with a pneumatic-tyred rail coach have recently been carried out by the London, Midland and Scottish Railway Company on their Bletchley-Oxford line. The coach has been constructed to the design of the Michelin Tyre Co., and weighs about five tons. It is mounted on five pairs of wheels, and has seating accommodation for 24 passengers. On a non-stop journey from Oxford to Bletchley—a distance of 31 miles—the average speed was approximately 50 miles per hour, the coach attaining nearly 60 miles per hour over several stretches of the route. The coach proved to have good acceleration, and a speed of 50 miles an hour was attained within a distance of 1,000 yds. from a stationary position. Needless to say, it moved remarkably smoothly and practically noiselessly. It is claimed that the tyres have a life of about 20,000 miles, and the trials show distinct possibilities of these coaches for branch line services.

A Large Canal Merger.

The ideal of a Royal Commission on Canals in 1909, which embraced the converging of the four main water routes on the Midlands will be practically realised by the important step taken recently, when three important Midland canal undertakings—the Leicester and Loughborough Navigations and the Erewash Canal—came under the control of the Grand Union Canal Co. This development will give immediate advantage to the important industries that are served by the various waterways now linked to London under unified control, because the modern plant and water reservoirs owned by the Grand Union Canal Co. will now be available for clearing the channel, freeing the surface of ice in wintry weather, and maintaining the water level. Canal users throughout the main Midland industrial field will therefore have the satisfaction of knowing that water transport delays due to drought or ice will be overcome with the increased efficiency resulting from unified control. This merger will bring under the control of the Grand Union Canal Co. a further forty miles of waterways, serving Leicester, Loughborough, Nottingham, and the Erewash Valley. Ultimately the newly acquired canals will be brought up to the standard to which the Grand Union Canal is being raised under the company's £1,000,000 improvement scheme.

Iron and Steel Report.

The Government's scheme for a 10 per cent. tariff has been generally welcomed by the British iron and steel trades, although only so far as steel rollers are concerned, because it represents what they hope will ultimately develop into the full measure of protection that they have been demanding for so long. In itself, the 10 per cent. will go only a small way towards spanning the price gap between their own products and those which foreign manufacturers, chiefly Continental, are selling on the British markets. This point of view they have stressed since the tariff proposals were first made public, and a similar attitude has been taken up by the engineering industry and expressed in an official statement issued by the British Engineers' Association. What they are both expecting is that the Tariff Commission which is to be set up will take early steps to consider the position and adjust the tariff to what they consider are the real needs. The finished iron trades are also looking to a higher tariff duty to help them solve their problems.

Pig-iron makers, however, appear to be more satisfied with the basic duty, for in their case in several important consuming areas competition from Continental pig iron has almost entirely disappeared of late, whilst in others, especially since the departure from the gold standard, the margin in favour of the foreign iron has become appreciably narrower. Moreover, they are not without hope that, ultimately, they will benefit from an increased demand for their own products through the diversion of orders, amounting to a fairly substantial aggregate tonnage, for iron and steel castings which British firms have been placing with Continental foundries.

With regard to trade in iron and steel products during the past month, the general experience in most parts of the country since the beginning of the year has not been too satisfactory. For the most part, foundry iron makers have had little of which to complain from the point of view of deliveries into consumption against contracts already on their books. On the other hand, there has been a very distinct absence of new buying interest in most centres, and this is occasioning a good deal of disquiet among ironmasters. Fortunately, the pipe and other foundries associated with some of the leading pig-iron concerns are taking good quantities of material, though, even so, the surplus is much more than sufficient to meet current needs of outside users. The price position in the foundry iron market has shown little or no alteration of late. For delivery to consumers in the Manchester price zone, Derbyshire, Staffordshire, and North East Coast brands of No. 3 iron are quoted on the basis of 67s. per ton, with Northamptonshire at 65s. 6d., Derbyshire forge at 62s., Scottish No. 3 at 87s., and West Coast hematite at about 81s.

The demand for bar iron has shown little or no improvement of late, and the movement in this section continues to be restricted, especially in the nut and bolt and similar using industries by the heavy stocks of the much cheaper foreign bars. There has, however, been no change from the prices ruling of late for the British products.

In most parts of the country the demand for structural steel remains at a very low ebb, and sales of shipbuilding materials are also considerably below normal. Boiler makers and locomotive builders are all very short of work, and, in fact, in the majority of branches of the principal heavy steel consuming industries business is on a very disappointing scale. In some of the lighter branches, conditions are more satisfactory, and sellers of special alloy steels have done a moderate business of late. Boiler plates have displayed some easiness during the past month, but there has been no alteration in the price position of the controlled products.

There has been little change in prices of Continental iron and steel products offered here, and the chief feature continues to be the anxiety of buyers to secure delivery of materials before the tariff comes into operation.

Some Contracts.

Messrs. Swan Hunter and Wigham Richardson, Ltd., Wallsend, have secured an order for a vessel from Messrs. Tatham Bromage and Co., Ltd., on behalf of Messrs. F. K. Warren, of Halifax, Nova Scotia. The vessel will be constructec at the Wallsend yard, and will be replica of the vessel "Moyra," built by this firm for the same owners last year. It will have a length of 257 ft., 39 ft. 6 in. in breadth, and 24 ft. 4 in. in depth, with a deadweight capacity of 2,550 tons on a light draught. The vessel is intended for service between ports on the St. Lawrence and the Great Lake, and will be designed for both ocean and lake service. The propelling machinery, which will consist of triple expansion engines, will also be installed by Messrs. Swan Hunter and Wigham Richardson, Ltd.

Messrs. Purdie, Lumsden and Co., Ltd., of Newcastle, have received a contract from the London and North-Eastern Railway Co. for the construction of a new bridge between Glaisdale and Egton, to replace the structure destroyed by floods last winter. Messrs. Samuel Butler and Co., Ltd., of Leeds, are to supply the steelwork.

The De Haviland Aircraft Co., Ltd., has concluded an important contract with the Norwegian Government under which the "D.H. Tiger Moth" will be built in Norway. The "Gipsy 3" engines which are fitted in the "Tiger Moth," will be imported from England.

Messrs. Dorman Long and Co., Ltd., Middlesborough, have been awarded a contract for the supply of a street railway track by the Edmonton City Council; also an order for 1,000 tons of tramway rails for Montreal.

Messrs. Stewart and Lloyd, Ltd., Glasgow, have secured an order from Messrs. Warren and Stuart for the manufacture and supply of 17,800 ft. of bitumen-lined lap-welded steel pipes, with bitumen-lined steel specials, and cast-iron specials.

Messrs. Tangyes, Ltd., Birmingham, have secured an order for the supply of two pumping sets for the Isle of Dogs Pumping Station.

Messrs. Courtney and Co., Belfast, have been awarded the contract for the erection of a mill at the dock of J. Rand, Ltd., Hull.

Ruston and Hornsby, Ltd., Lincoln, have received an order from the Russian Government for 100 sets of trunk-piston, airless-injection, four-stroke cycle heavy-oil engines for installation in new fishing vessels.

The Burntisland Shipbuilding Co., Ltd., have received a repeat order for one of their "Economy" steamers of 7,800 tons, deadweight, from the Alexander Shipping Co., Ltd.

Alexander Hall and Co., Ltd., Aberdeen, have received an order from the James Dredging, Towage, and Transport Co., Ltd., London, for a steel screw suction hopper reclamation dredger, 200 ft. in length, to be used at Southampton in connection with the big dock extension and reclamation scheme.

The Mitchell Conveyor and Transport Co., Ltd., have received an order from The Gas Light and Coke Company, London, for a coal handling installation at their Beckton works.

The Furness Shipbuilding Co., Ltd., Haverton Hill-on-Tees, have secured an order for a tanker. The vessel, which is of 2,800 tons deadweight, is to be built for Canadian owners.

We have been informed that the manufacturing and selling rights of the Vickers' Works Projection Microscope have been taken over by Messrs. Cooke, Troughton, and Simms, Ltd., and Messrs. Wild-Barfield Electric Furnaces, Ltd., have been appointed distributors.

MARKET PRICES

ALUMINIUM.

98/99% Purity		£95 0 0

ANTIMONY.

English		£40 0 0
Chinese		28 5 0
Crude		22 0 0

BRASS.

Solid Drawn Tubes	lb.	9¾d.
Brazed Tubes	lb.	11¾d.
Rods Drawn	,,	8¾d.
Wire	,,	8¾d.
*Extruded Brass Bars	,,	4½d.

COPPER.

Standard Cash		£35 7 6
Electrolytic		40 5 0
Best Selected		38 0 0
Tough		38 0 0
Sheets		72 0 0
Wire Bars		41 10 0
Ingot Bars		41 10 0
Solid Drawn Tubes	lb.	11d.
Brazed Tubes	,,	11¼d.

FERRO ALLOYS.

‡Tungsten Metal Powder	lb.	0 1 11½ Plus 20%
‡Ferro Tungsten	,,	0 1 8½ Plus 20%
Ferro Chrome, 60-70% Chr. Basis 60% Chr. 2-ton lots or up.		
NOMINAL 2-4% Carbon, scale 12/- per unit	ton	34 10 0
4-6% Carbon, scale 8/- per unit	,,	24 0 0
6-8% Carbon, scale 8/- per unit	,,	23 0 0
8-10% Carbon, scale 8/- per unit	,,	22 10 0
§Ferro Chrome, Specially Refined, broken in small pieces for Crucible Steel-work. Quantities of 1 ton or over. Basis 60% Ch. Guar. max. 2% Carbon, scale 11/6 per unit	,,	36 0 0
Guar. max. 1% Carbon, scale 15/- per unit	,,	40 10 0
§Guar. max. 0.7% Carbon, scale 15/- per unit	,,	51 0 0
‡Manganese Metal 96-98% Mn.	lb.	0 1 3
‡Metallic Chromium	,,	0 2 6
§Ferro-Vanadium 25-50%	,,	0 12 8
§Spiegel, 18-20%	ton	6 17 6
Ferro Silicon—		
Basis 10%, scale 3/- per unit	ton	5 17 6
20/30% basis 25%, scale 3/6 per unit	,,	7 12 6
45/50% basis 45%, scale 5/- per unit	,,	10 17 6
70/80% basis 75%, scale 7/- per unit	,,	16 8 6
90/95% basis 90%, scale 10/- per unit	,,	23 0 0
§Silico Manganese 65/75% Mn., basis 65% Mn.	,,	11 5 0
§Ferro-Carbon Titanium, 15/18% Ti	lb.	0 0 6
Ferro Phosphorus, 20-25%	ton	19 2 6

FUELS.

Foundry Coke—		
S. Wales	£1 2 6 to	1 7 6
Sheffield Export	0 18 0 to	0 18 6
Durham	0 14 6 to	0 15 0
Furnace Coke—		
Sheffield	0 12 0 to	0 12 6
S. Wales	0 17 6 to	0 18 0
Durham		0 14 6

GUN METAL.

*Admiralty Gunmetal Ingots (88 : 10 : 2)		£50 0 0
*Commercial Ingots		42 0 0
*Gunmetal Bars, Tank brand, 1 in. dia. and upwards	lb.	0 0 9½
*Cored Bars	,,	0 0 11½

LEAD.

Soft Foreign		£14 13 9
English		16 0 0

MANUFACTURED IRON.

Scotland—		
Crown Bars, Best		£10 5 0
N.E. Coast—		
Rivets		11 0 0
Best Bars		10 10 0
Common Bars		10 0 0
Lancashire—		
Crown Bars		9 15 0
Hoops	£10 10 0 to	12 0 0
Midlands—		
Crown Bars	£9 15 0 to	10 0 0
Marked Bars		12 0 0
Unmarked Bars		—
Nut and Bolt Bars	£8 7 6 to	8 12 6
Gas Strip		10 12 6
S. Yorks.—		
Best Bars		10 15 0
Hoops.. Hoops	£10 10 0 to	12 0 0

PHOSPHOR BRONZE.

*Bars, "Tank" brand, 1 in. dia. and upwards—Solid	lb.	9½d.
*Cored Bars	,,	11½d.
†Strip	,,	11d.
†Sheet to 10 W.G.	,,	11½d.
†Wire	,,	12d.
†Rods	,,	11½d.
†Tubes	,,	1/5
†Castings	,,	1/1¼

†10% Phos. Cop. £30 above B.S.
†15% Phos. Cop. £35 above B.S.
†Phos. Tin (5%) £30 above English Ingots.

PIG IRON.

Scotland—	
Hematite M/Nos.	£3 8 6
Foundry No. 1	3 12 0
,, No. 3	3 9 6
N.E. Coast—	
Hematite No. 1	3 5 6
Foundry No. 1	3 1 0
,, No. 3	2 18 6
,, No. 4	2 17 6
Cleveland—	
Foundry No. 3	2 18 6
,, No. 4	2 17 6
Silicon Iron	3 1 0
Forge No. 4	2 17 0
N.W. Coast—	
Hematite	3 14 6
Midlands—	
N. Staffs Forge No. 4	3 1 0
,, Foundry No. 3	3 6 0
Northants—	
Forge No. 4	2 17 6
Foundry No. 3	3 2 6
Derbyshire Forge	3 1 0
,, Foundry No. 3	3 6 0
West Coast Hematite	4 3 6
East ,, ,,	3 4 6

SWEDISH CHARCOAL IRON AND STEEL.

Pig Iron	£6 0 0 to £7 0 0
Bars, hammered, basis	£16 10 0 ,, £17 10 0
Blooms	£10 0 0 ,, £12 0 0
Keg steel	£32 0 0 ,, £33 0 0
Faggot steel	£18 0 0 ,, £24 0 0

All per English ton, f.o.b. Gothenburg.

SCRAP METAL.

Copper Clean	£30 0 0
,, Braziery	27 0 0
,, Wire	—
Brass	21 0 0
Gun Metal	26 0 0
Zinc	7 0 0
Aluminium Cuttings	62 0 0
Lead	12 10 0
Heavy Steel—	
S. Wales	2 7 6
Scotland	2 2 6
Cleveland	2 2 6
Cast Iron—	
Lancashire	2 8 0
S. Wales	£2 7 6 to 2 8 6
Cleveland	£2 5 6 to 2 7 6
Steel Turnings—	
Cleveland	1 12 6
Lancashire	1 2 6
Cast Iron Borings—	
Cleveland	1 6 0
Scotland	1 12 0

SPELTER.

G.O.B. Official	—
Hard	£10 10 0
English	14 10 0
India	12 15 0
Re-melted	12 12 0

STEEL.

Ship, Bridge, and Tank Plates—	
Scotland	£8 15 0
North-East Coast	8 15 0
Midlands	8 17 6
Boiler Plates (Land), Scotland	9 0 0
,, ,, (Marine) ,,	—
,, ,, (Land), N.E. Coast	10 0 0
,, ,, (Marine) ,,	10 10 0
Angles, Scotland	8 7 6
,, North-East Coast	8 7 6
,, Midlands	8 7 6
Joists	8 15 0
Heavy Rails	8 10 0
Fishplates	12 0 0
Light Rails	£8 10 0 to 8 15 0
Sheffield—	
Siemens Acid Billets	9 2 6
Hard Basic	£8 2 6 and 8 12 6
Medium Basic	£6 12 6 and 7 2 6
Soft Basic	6 0 0
Hoops	£9 10 0 to 9 15 0
Manchester—	
Hoops	£9 0 0 to 10 0 0
Scotland, Sheets 24 B.G.	10 5 0

HIGH SPEED TOOL STEEL.

Finished Bars 18% Tungsten	lb.	2/9
Extras		
Round and Squares, ½ in. to ¼ in.	,,	3d.
Under ¼ in. to 3/16 in.	,,	1/-
Round and Squares 3 in.	,,	4d.
Flats under 1 in. × ⅜ in.	,,	3d.
,, ,, ½ in. × ¼ in.	,,	1/-

TIN.

Standard Cash	£136 5 0
English	137 10 0
Australian	137 10 6
Eastern	144 0 0
Tin Plates I.C. 20 × 14 box	14/- to 14/9
Block Tin (Cash)	£138 5 0

ZINC.

English Sheets	£24 10 0
Rods	30 0 0
Battery Plates	20 5 0

* McKechnie Brothers, Ltd., quoted Feb. 11. † C. Clifford & Son, Ltd., quoted Feb. 11. ‡ Murex Limited, quoted Feb 11

Subject to Market fluctuations, Buyers are advised to send inquiries for current prices.

Prices quoted Feb. 11, ex warehouse.